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**JUNK IS AMERICA'S RICHEST WAR BRIDE**—[See page 328]

# The Belgian Congo*

## Facts Relating to Its Economic Development

By M. Horn, LL.D. (Brussels)

Few questions today occupy a more prominent position in our minds than those relating to the economic resources of the nations between whom the present war has established new or closer ties.

A fresh and acute interest has arisen as to the commodities which these nations are, or will in the near future be, in a position to produce for their own and each other's requirements, and as to the outlet which they will afford each other respectively for their surplus production.

Although the contribution which the Belgian Congo can offer, both as a source of supply and as a market, is as yet comparatively small, it may be found of sufficient importance to be taken into account in the consideration of these great problems.

The size of this Colony, exceeding 900,000 square miles, is approximately equal to the combined area of the British Isles, Belgium, France, Portugal, Spain, Germany, Switzerland and Italy, and it affords a variety of natural conditions and resources hardly less great than that which we all know to exist in the last-mentioned group of countries.

Nobody can boast of having actually seen and of thoroughly knowing more than a small portion of the Colony. Those who are in the best position to form an independent opinion based not only on direct experience, but also on information gathered from numerous and varied sources, will, I think, agree that, in a general way a more accurate impression is conveyed by Stanley's writings than by the great majority of later publications.

Stanley, let us remember, had traveled very slowly right across the country, making observations and drawing inferences, with an unprejudiced and marvelously perspective mind. As is frequent with men blessed with the gift of imagination, he appears to have underestimated the time which would be required for the possibilities he had recognized to become realities. But fresh evidence is continuously accruing in support of the conclusion at which he arrived 42 years ago, viz., that this area, of which he was the principal discoverer, "excels all other known lands for the number and variety of precious gifts with which Nature has endowed it."

It may be assumed that almost every kind of mineral wealth will ultimately be discovered in some part or other of the Colony.

Among those of commercial interest the best known at present are the copper and tin deposits of Southern Katanga, the goldfields of the north-eastern districts, the coal-seams of the Lukuga (Tanganyika district), the diamond-iferous alluvia of the Upper Kasai, and the conspicuously abundant resources of iron ore of the Uele and Ituri.

Elsewhere there are definite indications of copper, gold, lead, diamonds and oil, and there can be no doubt that more widespread and fuller prospecting will lead to many fresh discoveries of mineral wealth in the enormous mountainous crescent which encircles the Congo basin.

There is everywhere abundant material for building and road-making. In all probability kaolin will be some day exported from the coastal region. A fear which obtained until recently that there might be a deficiency of lime for the manufacture of cement and for agricultural purposes has since been dispelled.

To most minds, perhaps, the mention of the Congo will conjure up glorious visions of primeval tropical forests. Although large stretches of such forests are less frequent than may be commonly believed, yet the exuberance of the natural vegetation can hardly be exaggerated. The Congo contains practically inexhaustible stores of wood and fibrous material—fibres suitable for the manufacture of bags, ropes and brushes; wood in abundance for fuel and timber, ebony and mahogany besides tanning and dye wood.

Need I mention the rubber trees and vines, the reserves of which Nature indefatigably replenishes?

Unlimited supplies of gum copal are embedded in the marshy regions of the central districts.

Perhaps the most valuable assets among this vegetable wealth are the oil-bearing plants, the most conspicuous of which is the oil palm (*Elæis guineensis*), scattered by tens of millions in clusters, groves and forests, over nearly the whole of the Colony. In this connection it may be of interest to note that an opinion current in British West Africa, and which may be well founded there, viz., that the oil palm will not thrive beyond a comparatively small distance from the coast, by no means applies to the Belgian Congo, where luxuriant palm forests are found more than eight hundred miles from the sea border. A further natural advantage of the Congo worthy of mention is that, in the equatorial zone, among other plants the oil palm yields a continuous supply of fruit all through the year.

Elephants appear to be as numerous as ever, notwithstanding all the hunting to which they have for many years been subjected, and the statistics show no decrease in the output of ivory.

For the big game hunter the Congo affords a most attractive and varied field.

Beeswax, perhaps less plentiful than in other colonies, is offered for sale on the native markets, notably in the Upper Kasai and Upper Lulua regions.

Large quantities of African silk (anaphe nests) are reported in the central and northeastern districts.

Of all the potentialities of the Congo I should regard as most valuable its possibilities for agricultural development.

It is, I believe, by the production of agricultural commodities more than in any other direction, however important, that this Colony will ultimately be called upon to contribute to the well-being of the world.

Every kind of tropical or semi-tropical produce will prosper in the Congo, which is richly endowed with the two essential factors—heat and moisture.

Looking from east to west, we first find the hot and rather insalubrious coastal region less than eighty miles wide. Then, crossing the range of Crystal Mountains over heights of 1,500 feet and more, we reach the Stanley Pool (660 feet). Beyond this point a fan-shaped plateau rises gradually southward and eastward, with an increasingly temperate climate. The altitude of the southern country ranges from eight hundred to five thousand feet. Snow-covered peaks of over eighteen thousand feet are comprised in the eastern crest.

In the equatorial zone the rainfall (sixty to eighty inches), is evenly distributed all through the year, and the temperature shows but slight variations. Seasons become more accentuated as we get farther from the equator. In Upper Katanga, for instance, the rainy season in 1915 lasted seven months (seven to twenty-nine days of rain per month), and the dry season five months (four to seven days of rain per month), the total rainfall amounting to 52 inches and the temperature varied from 38.8°F. (July minimum) to 92.8°F, (November maximum.)

The soil is by no means uniformly fertile. While there are many tracts of rich loam, notably in the volcanic regions west of the Great Lakes, sandy soils are predominant. Considerable areas have been impoverished by the primitive methods of cultivation practised for generations by the natives; and even in forest land the top soil is frequently only 20 inches deep. True, there is a good deal of poor land, but before the necessity can arise to turn this to account, millions of acres which require little or very little improvement will be found available for native and European enterprise, far in excess of what we could ever hope to see fallowed or planted in the near future.

Into this mass of natural wealth Providence has thrown an incomparable system of navigable highways—the mighty Congo River and its tributaries.

The majority of these streams, of comparatively recent formation, are intersected by rapids in their higher reaches, and the mountainous girdle of the Congo basin traversing the main river in its last stretch causes those fateful breaks which, until the last half century, shut off Central Africa from the outside world.

Need I point out that the rapids, together with a multitude of mountain torrents, constitute inestimable reserves of motive power, and that between the broken sections lie over nine thousand miles of navigable water?

All the natural wealth of the country would be of no avail without human energy to turn it to account.

The native population of the Colony may be put down at fifteen millions (estimates vary from twelve to eighteen millions). The census operations have not yet extended to the more remote areas, and even in other parts they are hampered by a well-founded suspicion that registration entails Government supervision.

It has often been asserted that the territories which today form the Belgian Congo are less populated than when they first came under European rule. This opinion appears to be generally based on the fact that certain areas, which at one time were found to be well inhabited, are today almost deserted. It should, however, be borne in mind that many Central African tribes were, until recently, and to some extent are yet *e. g.*, in the southern parts of the Kwango and Kasai districts), habitually nomadic; that their exhausting agricultural methods entailed in particular the abandonment of the most extensively cultivated tracts of land; that, moreover, disease, as well as a desire to avoid the white man, have frequently caused the native to withdraw from the main thoroughfares into the interior.

So much is certain: European rule has freed the aborigines of the Congo from the Arab slave raids and from inter-tribal warfare. Poison-ordeals, cannibalism, and other causes of violent death have been practically stamped out; the slave traffic in the interior will soon be extinct; hemp-smoking and other vices are severely repressed, and polygamy is being gradually reduced. All of these circumstances are obviously or presumptively conducive to an increase of population.

As already mentioned, the climatic conditions of the Colony vary widely according to the altitude of the different regions. Certain parts, notably the marvellous country west of Lake Albert and of Lake Edward, may be fairly compared with the Rivera. The Upper Katanga and Upper Kasai can properly be described as a white man's country; and there is, so to speak, no portion of the Congo in which the European could not reside for a considerable number of consecutive years. Precautionary habits and sanitary improvements will gradually eliminate those malarial diseases which constitute the principal, and I may say the only serious, danger which threatens the European settler.

At the last complete census (1912) the white residents numbered 5,465, of which 3,307 (60.5 per cent) were Belgians and 505 (9.25 per cent) British.

There is a growing influx of Arab and Hindu traders and craftsmen from the Sudan and from Uganda. In my opinion this should be welcomed: the adequate development of the Colony requires that the energies of the aboriginal population should be leavened by the influence of more advanced races, and I believe that white emigration alone cannot fulfil this end.

From an economic point of view the aborigines are of unequal value. Ethnically they comprise such different types as the pygmies of the Aruwimi forests, and the long-legged plain-dwellers of the Upper Uele. There are tribes which can be specifically described as hunters fishermen, pastors, and farmers. Some have attained a considerable proficiency in the arts of weaving and pottery, and in iron and copper work; others show hardly any traces of even the most rudimentary civilization. If vice and disease have brought certain races to a deplorable state of degeneration, the majority are muscular and healthy, or will speedily become so when they are taught to increase their supplies of vegetable and animal food and enabled to add to their diet a sufficiency of salt.

There is abundant proof that a very large section of the Congo natives show remarkable aptitude for learning the handicrafts of the white man. Some are already rendering valuable services as mechanics, engine-drivers, clerks, interpreters, typists, compositors, and telegraph operators. In the recent campaigns the native troops, drawn from various regions, have almost invariably shown the highest discipline and valor.

Although with few exceptions these peoples are peaceable and tractable, yet European enterprise in dealing with them finds itself frequently hampered by difficulties arising from their domestic organization and the modesty of their wants.

European industrial and agricultural undertakings necessitate the regular employment of trained and more or less skilled workmen. The use of female labor for tasks which require physical strength is abhorrent to the civilized mind.

Now, generally speaking, the Congo native has from time immemorial been accustomed to throw on his women folk the burden of heavy work other than clearing, and he has a strong abhorrence to disciplined exercise for any protracted time. Moreover, where, as is the case almost in every part of the Congo, it has been the habit of each family or group of families to cultivate severally all produce required for the sustenance of its members, the laborer engaged in European employ will naturally feel a strong desire to leave his employer in order to take part in the selection and clearing of the patch on which the family crop is to be grown.

As regards the difficulties arising from the small needs of the native, we must consider that in the less accessible parts of the Colony his desire for imported goods is practically limited to a few yards of cloth and a few bags of salt for personal use or for the purchase of wives. The necessity of obtaining a small amount of cash to meet the demands of the tax-collector is often his only addi-

*Abstracts from an address before the Royal Society of Arts. Republished from the *Journal of the Society*.

tional inducement to seek temporary employment, or to offer for sale a modicum of produce, fish or live stock. This would appear to justify the paradox that with such primitive people a rise of wage or price would tend to decrease the supply.

After this, I fear, rather superficial survey of the natural gifts of the Colony, let us rapidly go over what has been done to develop its latent resources and summarize the results so far achieved.

The authority of the State is today so well established that the trader and even the tax-collector can safely travel unarmed and unescorted almost anywhere throughout the Colony. During this war the natives have given most gratifying proof of their loyalty to King Albert and of their attachment to Belgian rule. The townships and minor State posts number 487.

The present administrative organization is based on that which the genius of King Leopold conceived and brought into being with astounding celerity. But it has been remodeled in many respects.

By a Royal Decree, signed on the eve of the war (July 28th, 1914), the territory of the Colony is divided into four provinces—viz., the Congo-Kasai, Equator, Oriental, and Katanga Provinces, of which the chief cities are respectively Kinshasa, Coquilhatville, Stanleyville, and Elizabethville.

The executive head of each province is a Vice-Governor, assisted by a complete and distinct staff of officials. The Vice-Governors are subordinate to the Governor-General, whose present residence is Boma, and who is, in the Colony, the representative of the King and supreme head of the whole civil and military administration.

It should be mentioned that the final organization of the two first-named Vice-Governments has been delayed in consequence of the war.

The unit of administration is the district, in which the District Commissioner is the sole authority and has at his disposal a number of financial, technical, medical, agricultural and military officers. The district is divided into territories, the territorial administrators acting under the direct control of the District Commissioner. The districts, of which there are 22, comprised in the provinces already referred to, have all been organized in their present limits from 1912 to 1915.

In the delimitation of these territories the native tribal divisions have, so far as possible, been taken into account. The aboriginal population is being grouped into chiefdoms and sub-chiefdoms, the greatest care being taken to establish the authority of those individuals who, according to native custom, are entitled thereto. More than four thousand chiefdoms have already been organized. These communities are called upon to co-operate in administrative measures directly beneficial to themselves—such as road-making and protective clearing against sleeping-sickness—within the limits of their own chiefdom. Their chiefs exercise such traditional powers as civilization can tolerate, and act as intermediaries between their subjects and the administration.

At the end of 1914 a force of 1,800 native policemen and nearly eighteen thousand native soldiers, commanded by European officers and non-commissioned officers, was employed or held in readiness for the maintenance of public peace in the Colony. Recent events have demonstrated the value of these effectives, but that they were greatly in excess of the requirements for which they were intended; although a large proportion of this force has been on active service "abroad," its absence has not given rise or led to local unrest.

The most effective way of opening up the country for investigation and trade is, of course, by development of the means of communication.

On the abnormally small ocean front which has been alloted to the Congo in consequence of the historical claims of Portugal, there is only one port, that of Banana, at the mouth of the river. But ocean-going vessels ascend the huge stream up to Matadi, close to where—100 miles from its mouth—its course is interrupted by the first rapids. An additional port will shortly be established at Ango-Ango, three miles lower down.

A little more than half-way up this stretch is the port of Boma, which serves as an outlet for the produce of the Mayumbe district.

As regards the gigantic system of waterways in the Upper Congo, these rivers are, generally speaking, comparatively shallow in consequence of their unusual breadth. (The main river towards the summit of its curve attains a width of 20 miles.) In consequence the steamers supplying the Upper Congo do not as a rule exceed a three-foot draught, and are usually of the stern-wheel or tunnel-screw type.

There are at present on the Upper Congo about one hundred steamers, of which 45 are State-owned or State-controlled, in addition to a number of barges and whale-boats. The aggregate carrying capacity of this river fleet amounts to about nine thousand tons.

The three comparatively short sections on which the course of the main river is interrupted by rapids have been supplemented by railroads.

At the very foundation of the Congo Free State the urgent necessity of a railway to connect the Upper Congo with the ocean was recognized as essential to the success of King Leopold's venture. Without this connection nothing but the most valuable produce could be exported, and that only by the costly and painful means of human carriers over a mountainous country. Animal transport had been tested and had proved a failure.

Begun in 1893 the Congo Railway was completed, despite many difficulties, within six years. Well built and well equipped, this narrow-gauge line (27.8 inches) of 250 miles—which has cost, including accessory buildings, about three and a half millions sterling—has so far sufficed to deal with the traffic of the Upper Congo and of the adjoining districts of French Equatorial Africa But the time is close at hand when, without extensive constructional improvements, it will be quite inadequate to convey towards the ocean the growing flow of heavy produce.

Practical means of transport being established between the seaports and the waterways above the first group of rapids, a magnificent reach of the main river, 1,200 miles in length, as well as the principal tributaries, were rendered accessible to commerce.

But in order that the whole of the great semi-circular high road which Nature has traced through this country might be laid open to traffic by steamship or rail, the Stanley Falls and a further stretch of rapids remain to be negotiated. The railway by which these obstacles have been overcome was completed in 1900, and comprises two sections—viz., Stanleyville-Ponthierville (83 miles) and Kindu-Kongolo (222 miles). Stern-wheelers of 250 tons ply on the intermediate water and up to the terminus of the navigable Congo, Bukama, 2,200 miles from the mouth of the river.

The natural outlet of the Colony towards the Atlantic having been thus improved, attention was turned to the means of connecting this channel of communication with the Indian Ocean and the South African railway system.

While the administration of German East Africa was actively pushing forward the line from Dar-es-Salam *via* Tabora to Ujiji-Kigoma with a view to commercial and, perhaps, other penetration into Northern Katanga, a railway (169 miles) was placed under construction on the Belgian side of Lake Tanganyika, starting from Kabalo and reaching the lake at Kalemie, somewhat south of the township of Albertville. This line, which was completed towards the end of 1915, has rendered conspicuous service during the present war. It was designed mainly to open up a very promising coal and tin country where successful mining operations are already in progress.

With a view to avoid transhipment to Kabalo and Kongolo, a railway connection will, no doubt, in the near future be established alongside the navigable river between these two points, which are hardly 40 miles apart.

It is now possible to travel from the Pacific to the Atlantic right across Central Africa from Dar-es-Salam *via* Stanleyville to Banana within the space of a month.

Elizabethville, the capital of the Katanga province, still had to be linked up with Boma, the capital of the Colony, and the discovery of the stupendous copper deposits north of the first-named locality warranted an additional more rapid and, perhaps, more convenient communication with the ocean.

In 1909, after five years of preliminary survey and as soon as all doubt was dispelled as to the extension of the Rhodesian line to the Congo frontier, the construction of a railway between the British terminus and Bukama was definitely decided upon. The work has been carried on from both sides simultaneously, and, were it not for the present shortage of rail plant, would by this time have been completed. As it is, nothing is required to connect the two finished sections (50 miles from Bukama and 370 miles from Sakania on the Rhodesian frontier) but the laying down of sleepers and rails on a stretch of 50 miles, and an overland route between the lower Congo and Cape Town will be thus established.

I have only one other railway to mention—viz., the narrow-gauge (24-inch) line of the Mayumbe. This leads from Boma due north through prosperous cocoa plantations and plentiful palm groves to Tshela on the Lubudi, an affluent of the Shiloango (85 miles). The line will shortly be e tended to this river, with which it will then compete for the export of agricultural produce from a comparatively small but thickly-populated region.

The aggregate length of fully-equipped public railways today stands at 1,229 miles, of which more than two-thirds (851 miles) have been constructed in the last eight years—*i. e.*, since Belgium took over the administration of the Congo.

The north-eastern districts and at the opposite corner of the Colony, the southern regions of the Kwango and Kasai districts, in which there is little navigable water, must be provided with railroads.

A considerable traffic, passing mainly through Aba, is rapidly developing between the Sudan and the north-eastern districts of the Colony; Greek and Arab traders are bringing goods into the wholesale stores of Khartoum and taking out considerable quantities of ivory and rubber. Moreover, now that the great mineral wealth and climatic advantages of these regions have been realized, the importance of opening up this country has become more tangible.

Two almost parallel but by no means competitive lines are in contemplation. The first track would start from a point either near Bunba or near Basoko and extend via Buta through a rich palm country and the Moto gold-field to Aba. It is to be noted that access to Buta is at present afforded by the Itimbiri River, which, however, is impracticable to steamers during five months of the year.

The other line has already been surveyed. It would connect Stanleyville and Mahagi (Lake Albert) via Iruma with a branch to the Kilo and eventually to the Moto gold mines.

Today the bulk of the Upper Katanga output is carried southward and shipped from Beira. A few months hence the alternate route of Bukama-Stanleyville-Matadi will open. A third—shorter and perhaps cheaper—channel to the ocean, the Benguella railway, will probably be available at a not far distant date. A fourth track has already been fully surveyed which, crossing the tributaries of the Kasai River at approximately their navigable termini, would connect the Katanga railway with the Lower Congo line.

Finally, it should be mentioned that the French contemplate tapping the resources of the Congo basin by means of a line from the Atlantic to Stanley Pool (Brazzaville), of which a finished section, from the Pool to the copper-mines of Minduli is already feeding the Lower Congo railway. The Portuguese also are pushing forward their Northern Angola railway from S. Paolo de Loanda towards the Upper Kasai.

The presence of fly renders animal traction impracticable in the majority of districts, and the luxuriant vegetation and heavy rainfall make the upkeep even of metalled roads an arduous task.

Yet without a good network of roads the country could only partially be opened up for administration and commerce. The winding native paths cannot suffice.

Although a very large amount of work is urgently required to be accomplished in this direction, the aggregate length of State-built roads already exceeds 5,600 miles. This figure includes a motor road on which a motor transport service is established between Buta and Bambili (154 miles), connecting the navigable Itinbiri and the Uele River.

A company working the diamond mines of Tshipaka (Southern Kasai) has constructed a motor road alongside the Wissman Falls.

The following are the principal caravan routes generally provided with porterage services and rest houses: from Niangara to Aba towards the Nile; from Kilo to Moto; from a point above Ponthierville to Lake Kivu; from Lusambo to Ankoro (above Kabalo), and to Bukama; from Lake Moero to Elizabethville and towards Ankoro.

Speedy and, above all, cheap means of transport are to the Congo a matter of paramount importance for the development of its resources, the prosperity of its inhabitants, its commercial intercourse with the adjacent colonies, and its sea-borne trade.

Although superior to probably any other country in the abundance and variety of its natural gifts, its promise is impaired by one disadvantage—distance.

## Differential Refractometer for Measuring The Salinity of Sea Water

Measurements of the index of refraction can be used to determine the salinity of sea-water. In the method here given, monochromatic light from a collimator falls normally on one face of a rectangular glass vessel which is divided into two parts by a glass plate along one diagonal. Two prisms are thus obtained, and if they contain liquids of the same index the ray traverses the system with no deviation. If the two liquids have indices of refraction $n$ and $n'$, and the angle of the prisms is A, the deviation $\Delta = (n - n')A$. In order to measure this deviation the emergent beam is allowed to fall on a lens which gives a real image of the collimator slit. This image is then examined through a microscope provided with a micrometer eyepiece. The refractive index of a sample of sea-water is thus determined in terms of that of a standard sample. The method is very rapid, and has the advantage of requiring only a few $cm^3$ of liquid. In addition, it is susceptible of considerable accuracy.—Note in Science Abstracts on a paper by A. Berget in *Comptes Rendus*.

## The Autumn Moon

LUNAR theory has become recently an engrossing study for all, and is not to be classed such a useless abstraction as before. The peculiar behavior of the autumn full moon in our high latitudes has always attracted the attention of the hunter and farmer, and given it the name of harvest or hunter's moon, according as it comes next before or after the equinox.

This behavior, which has attracted attention and given the name, will be on view at this full moon; it will be noticed how the time of moonrise will be very nearly the same during the inside of a week, the full moon coming up at sunset, or a little before or after.

The full moon on September 30th was then, strictly speaking, the hunter's moon, but may also be called the harvest moon in that backward season. The previous full moon of September 1st, coming a month before the equinox, did not show up so clearly to a noticeable extent the peculiarity of a successive rising at sunset, with little or no delay.

The astronomical explanation is simple. At the autumnal equinox the full moon is passing through the ascending node of the ecliptic at the vernal equinox, and its motion from south to north of the ecliptic is quickest.

The usual retardation of rising due to the moon's motion along the ecliptic is diminished by the rapidly northing motion, and the effect is to reduce the retardation from an average forty-eight minutes daily in a month of 30 days to something considerably less, especially in high latitudes, where the retardation may sometimes be wiped out altogether, and the moon will rise earlier for a night or two. The same effect of diminished retardation takes place every month, while the moon is moving through the vernal equinox; but the effect passes unnoticed, as the moon is not full.

We begin by taking the moon to move in the ecliptic, but her orbit is really inclined at about five degrees, and the nodes of the orbit revolve in 18 years. The effect is not the same, then, every year, but greater or less; and the modification can be investigated on astronomical theory from the numerical data of the Nautical Almanac. In some conjunctions it will be possible to see the full moon travel round the horizon, in a latitude five degrees short of the Arctic Circle, as in the northern parts of Sweden.

The effect is reversed and the retardation of rising is greatest when the moon passes through the autumnal equinox and is receding most rapidly from the pole star, as in the last old and new moon a fortnight ago.

The full moon at the vernal equinox will rise, or set, from an hour to an hour and a half, or two hours, later each night, and advantage can be taken if moonlight is to be avoided.

The words in "Macbeth," "The moon is down . . . And she goes down at twelve. I take 't, 'tis later, sir," would imply a moon about a week old, and moving through the autumnal equinox, making midsummer the time of the play. Shakespeare's education has been called in question, but he can always be relied upon for accurate observation, and is not content to take his natural philosophy out of a book, second-hand and unverified.

The moon is full in passing through the autumnal equinox when the sun is opposite in the vernal equinox—that is, in spring. This full moon will be observed to be very late in getting up and in setting again; but it has not attracted attention, as unconnected with any influence on human life.

It may be called Endymion's moon, from the legend of Mount Latmos, where we may suppose Endymion, an astronomer, had built his observatory within reach of Miletus. In the legend he drew the moon goddess down by the arts of a Thessalian witch, and in the springtime would not let the goddess go in a hurry. The scene has been utilized by Hardy in "Two on a Tower."

Mount Hamilton, with the Lick Observatory on it, resembles Latmos in being within reach of San Francisco, The journey there is a favorite pilgrimage and, in contrast to our Greenwich, visitors are encouraged to cheer up the solitude of the staff, and provide merriment after they are gone by their innocent questions. One Lund divinity visitor was reported to take a great interest in the life of young Endymion, and curious of his habits, she asked, "What do you do all night?" "We take the observations." "What do you do all day, then?" "We reduce the observations." "But why cannot you take your observations the right size once for all?"

The erratic behavior of the moon in the sky has been a pitfall for artist and poet; the mistakes have provided much amusement to the astronomer. Turner, the artist, has painted the sun setting in the east in his picture of the old *Téméraire*. Hogarth's picture of "The Lady's Last Stake," now gone to America, in which Mrs. Thrale claimed to have sat for the lady's model, is intended to draw a moral on sitting up gambling all night, with the moon looking in reproachfully at the window. But the astronomer recognizes a winter new moon, and the hour is about five o'clock tea time, so we may imagine the other members will be knocking at the door and asking, "When are you two coming in to tea?"

We still speak of new moon and old, and so perpetuate the ancient theory of Pythagoras that the moon is not a celestial body coming round every month, but a sort of magic lantern shown on the sky. This doctrine of Pythagoras is still the orthodox theory in Turkey today, and to prove it, the national emblem of the Crescent shows a star shining through the moon; and Coleridge, in the first draft of "Christabel," is reported to have seated a star in the horns of the crescent.

**The Fairy Shrimps**

One of the most interesting crustaceans known is the little "fairy shrimp" which appears in the early spring just as the ice is leaving the fresh water pools. It is transitory in activity and its habits are not completely known.

It is a relative of the salt water shrimps. One of these latter, called *Artemia* is known to change its structure somewhat under varying degrees of salinity of the water.

This photograph was made by Mr. F. E. Chidester.

The sun and moon go round like the hands of a clock, hour and minute, on the old Chaldæan estimate of a year of 12 lunations of 30 days. Full moon would occur when the two hands are in lines directly opposite.

A sundial, marked to serve as a moondial, like the old dial at Queens' College, Cambridge, will give 48 minutes added to moonlight time for every day of the moon's age, to give the corresponding sun time on the average.

A moon clock of greater accuracy and variation is required to mark the time when the moon is down longer than usual, drawn down in the legend by Thessalian arts, when the witch loves to ride through the air in the dark.

In "All for Love; or, The World Well Lost," Dryden writes:

> Her eyes have power beyond Thessalian charm
> To draw the moon from heaven,

and this was considered just the time for us to be most on our guard, during the coming winter; although this expectation has not been realized of late.

In ancient astronomical lore as well as in poetry, the sun and moon were pictured as living bodies, and an eclipse could be described as drawing them down to earth, the moon and sun.

Prior information of an eclipse was of great service to counteract superstitious fear, and to claim the magic power as on your own side; as in the case of the solar eclipse predicted by Thales, related by Herodotus, occurring in the middle of an important battle.

A lunar eclipse is so common as to attract little attention today; the frequent occurrence compared with a solar eclipse attracted the attention of Aristotle. But the lunar theory involved could be utilized by the Thessalian magician, and would have proved valuable to the Athenian general Nicias in his disastrous retreat from Syracuse.—G. GREENHILL in *Nature*.

## The Beaver in Britain

THE beaver, which is prehistoric and even in early historic and mediaeval times was widely distributed over Europe, is now found in the Northern Hemisphere, (to which it is confined) under purely natural conditions only in Canada and Siberia. Colonies of them, with their lodges, canals, and dams, are indeed still in existence as at Arendal in Norway and in the district of Madgeburg in Germany, but if they can be said to flourish there it is under the protection of human laws made for the preservation of an interesting but fast-vanishing species. It is only in the neighborhood of the Caspian and among the streams of the Ural Mountains that flow into that inland sea that beavers can now be said to live in Europe as free denizens undisturbed by the special attention of friendly or hostile man. There is ample evidence that they were at one time comparatively common among the network of lakes and streams of Scandinavia, Switzerland, and Bosnia. Their remains are plentiful among the débris of Swiss crannogs, and have frequently been discovered near Sarajevo, in Bosnia, a country almost distinguished by the number of localities into the place-names of which the word *daber* (meaning beaver) has entered. There is a fair sprinkling of similar place-names in our own country, one which will readily occur of most readers being Beverley, in the East Riding of Yorkshire. The proof of the beaver's prevalence in earlier times in Britain is both geological and historical. It seems to have gone on about the same time as the reindeer with (in regard to England) the twelfth century, probably somewhat later in Scotland. According to tradition, it was last seen on the Teify, in Wales, and on the Ness, in the Scottish Highlands. It was known even in recent times among the Highlanders as the broad-tailed otter—*dobran losleathan*, a name which corresponds with the Welsh names for otter and beaver, *ddyfrgi* and *llosdlydan* respectively. Professor Walker of Edinburgh University, used to remark on its peculiar Gaelic name in his class-lectures on Natural History. Among country folk there seems to have been a mix up of badgers, otters, and beavers under the generic name of "water-brocks"—a singular expression which got into Scottish verse in the sixteenth century.

Gological traces of the beaver are pretty widely diffused over Britain. Its bones and its skeleton have been dug up from the beds of drained lakes, from marl-pits and peat-mosses, or have been come upon in caves and rock-shelters and among the remains of crannogs, in various localities from Somersetshire to Perthshire, including Berkshire, Norfolk, Yorkshire, Berwickshire, and Ayrshire. At Glastonbury its bones were found associated in the lake-village with the remains of our ordinary domestic animals—the ox, horse, sheep, pig, poultry; they have also been found among the food-refuse of neolithic man at Ardrossan. Whether its flesh was ordinarily eaten by primitive man is somewhat doubtful, but its wool and skin gave the animal a value in the household economy, and its hard enamelled incisors would seem to have furnished our rude forefathers with useful cutting and piercing implements. Its flesh is highly spoken of by modern gastronomists, unless when tainted by too prolonged or exclusive feeding on the roots of the water-lily. Cartwright, the well-known Canadian fur trader, preferred beaver flesh that had been reared on birch-bark (the animal's favorite food) to any kind of meat whatever; to him it was "the most delicious eating of any animal in the known world." In Norway the tail is "an epicurean dainty"—a delicate combination of fish, pork, and fowl. But the price is prohibitive, the fine for poaching a beaver amounting to over four guineas! No fossil remains of the beaver have been found in the neighborhood of Edinburgh. About a hundred years ago a beaver's skeleton was discovered in the Merse under a covering of peat about two yards thick, and some years earlier beaver bones and the horns of a reindeer were found at about the same depth in a drained part of Marlee Loch, in Perthshire. A similar find was made of reindeer and other mammalian bones in a fissure of the Pentlands at Dreghorn about 30 years ago, but no beaver remains were identified. Certain place-names, however, on the Pentlands would seem to indicate the former presence of the beaver among these hills; the old name of the Braid Burn, the Peffer, is supposed to be a variant of the word "beaver," and the legend of the name may possibly be read in Baberton and Bavelaw. There exists now only one species of beaver, but ancient geological records reveal various species that flourished in an age of monsters, in far-off Miocene times, one of them approaching in size the gigantic.—I. L. R. in the *Scotsman*.

# Anomalies of the Animal World—V.

## Due to Artificial Selection and Breeding

By Dr. R. W. Shufeldt

When we pass from what we find in nature—in the matter of abnormalities and anomalies among animals—to observe what is to be found all over the world, in places where man has bred a great many different kinds of animals to meet the ends of his demands for variety, for food and for gain, we meet with forms on all hands which, as representing departures from the usual and the normal, has nature outdone at every point. Such trade, experiments and exploits have been in vogue as far back as we care to trace them in history.

Some of the best examples of this are to be found in the vegetable world, and one has but to compare many of the vegetables found in our markets to day with the wild stock from whence they were derived by artificial selection, to appreciate what has been accomplished by such means. Some of the so-called "small fruits" furnish us with admirable examples, and as for flowers, their transformations from the wild species has been truly marvelous in hundreds of instances; while such experiments as Luther Burbank has succeeded in, and is successfully making, carries many tasks of the kind to the very limits of their capacity. Seedless melons; spineless cacti, and many similar productions, all to meet the tastes of mankind or to satisfy his greed of gain, are surely abnormal forms, if there be such a thing as an abnormality as a result following experimentation of this character.

But we have here to deal with animals and not flowers or fruits, instructive as the latter two are.

By artificial selection, any animal—including man—may be bred to finally assume any abnormality, any monstrosity, or any form we may elect *up to a certain limit*. To accomplish such ends, however, the experimenter must have a far-reaching knowledge of the several laws of organic evolution, and be a thoroughly equipped and practical biologist.

Many of our now domesticated species vouch for extraordinary achievement in such directions. Some few others, where not "improved," remain much as their relatives and respective species in the ferine state.

Little or practically nothing has been done or accomplished to improve our own species—the human species or races—by a rigid application of the methods to which reference is made; yet man is one of the most plastic organizations of all mammals now inhabiting the earth. Men and women may, by proper scientific selection, be bred to have any kind or color of hair; bred for intellectural, physical or other capacity; for health or for diseases; for beauty or for distorted features of every conceivable kind. Give me a thousand years to live; a suitable, uninhbiated island of a thousand square miles, in the proper climate, and every possible requirement to conduct the necessary experiments; then the right to select anywhere in the world one thousand couples of men and women for the purpose, and at the end of ten centuries you would see a group of people—comparatively very few in number—such as no one in the world, to my knowledge, has ever conceived of—that is, not as a eugenic triumph, as pictured through his or her most far-reaching stretch of imagination.

It has required, for all we know to the contrary, four or five centuries for the Chinese and Japanese to produce the remarkable forms of goldfish that they have. There are species of these in Japan that now sell in open market, for the aquaria of the rich, at $1,200 each. There are a number of kinds, single specimens of which fetch from $50 to $150 per specimen. (See illustration.) This demonstrated what can be done with a species of common carp *in time*.

Writing upon this subject, John Bickerdyke says that the "common carp is one of the most remarkable fishes which swim. In early times in England it was extensively cultivated as a food-fish, and in Germany at the present day is as much domesticated as the sheep, pig, or ox. The fish-culturists have indeed done extraordinary things with it, having, for instance, produced a variety with a single row of scales down each side, and sometimes on the back only, called the Mirror-carp or King-carp. Then there is also the Leather-carp, with no scales at all, which is much esteemed in Germany.

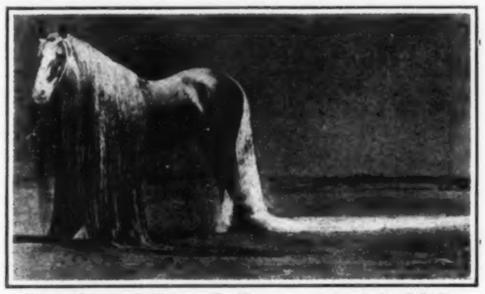
"There is reason to believe that the common carp was originally a native of the East, and it certainly has been domesticated in China for many hundreds of years. Thence it is supposed to have been imported to Germany and Sweden, reaching England some time in the early years of the fifteenth century. In that curious

[Note:—Owing to a typographical error, Part IV which appeared on August 18, No. 2172, was numbered Part III. Part III appeared in the issue of the Supplement of May 26th].

An imported Rynkin (from Japan)

work the "Boke of St. Albans," published in 1496, it is said that the carp is a 'dayntous fysshe, but there ben fewe in Englande, and therefore I wryte the lesse of hym.'

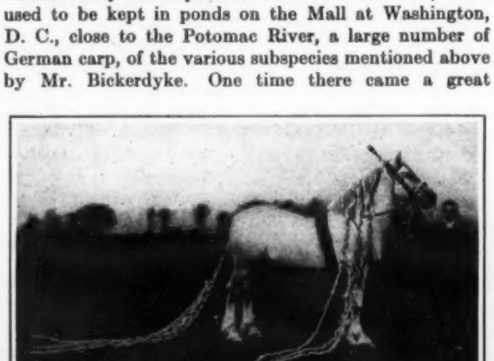
"China is the home of the goldfish, a pretty little carp common in that country and the warmer parts of Japan. The Chinese have distorted Nature with regard to this fish even more than the Germans have the common carp. Their most extraordinary monstrosity is, perhaps, the telescope-fish, which has a huge tail and



Two views of "Linus." From cuts in *Animal Life*

projecting eyes. It is believed that goldfish were not known in England before the year 1691."

What has been done with the common carp can be accomplished with any fish in existence. Moreover, if placed back in their normal habitats and allowed to revert to their normal forms, this feat is performed in an incredibly brief space of time. For instance, there used to be kept in ponds on the Mall at Washington, D. C., close to the Potomac River, a large number of German carp, of the various subspecies mentioned above by Mr. Bickerdyke. One time there came a great



"White Wings." Photo from a cut in *Animal Life*

flood, the river overflowing all of these ponds and allowing the carp in them to escape into it. In a very few years these fish reverted back to a form very much like the original stock or the carp that had been employed ages before to produce them, or rather their descendants. They are now taken in the Potomac River by the local fishermen and sold in the Washington fish markets as "sand-perch!"

What the fish-culturists have accomplished with the carp, the breeders of domesticated chickens have achieved by the same means, through artificial selection, in the case of those birds, by employing chiefly the red junglefowl of the Himalayas and Central India as the original or parent stock, the start having been made a number of centuries ago.

Most of us know now the marked differences to be seen in such breeds as the Plymouth Rocks, the Dorkings, Black Spanish, Andalusians, Leghorns, Minorcas, Dominiques, and a perfect domesticated avifauna of other curious and interesting kinds. Were these birds produced by natural selection in nature, any one of them would be considered a *new species* by the modern ornithologists; and probably the fancy cock, with his over six feet of beautiful tail—a feat accomplished by the fancy stock-breeders of Japan—would be honored through having a new *genus* created for him.

Many other domesticated fowls have been produced in precisely the same way; but it has always required from a dozen or more generations up to a mark among the centuries to do it. We see them among our own barn-yard turkeys, ducks, geese, and various others. This also applies to many cage-birds of various species; to a perfect host of pigeons, and to other remarkable forms, both big and little, all over the world. Many of these were used and described by Darwin in his work; and it was due to his personal experiments with pigeons that he was enabled to demonstrate what had actually happened in nature along similar lines, through natural selection, as effected in and under various environmental influences.

When we come to study the mammals along these lines, we meet with results which seem to be even more extraordinary than those to be found among any of the groups of animals below them. It is in this order that our own family is found, and now the production of all sorts of people, through the crossing of various stocks all over the world, is proceeding with marked rapidity. Phenomena of this character can be studied in almost any country, and perhaps there is no better example of it anywhere than we find in the city of Washington, the capital of the United States. Here we have the various stocks derived from Europe, representing, in their highest types, all that the race has accomplished in culture, refinement and advancement, crossing with a black stock derived from Africa, the parentage of which, in the latter country, is known to be as low in character as any race now inhabiting the globe. Only comparatively recently many of them were cannibals, and probably some of them are still. As a result, a lighter colored breed is now being rapidly produced which, as a whole, may be characterized as being not nearly as good as the best of the original black stock, and, in the case of a vast number of them, worse than their ancestors, the average Ethiopian or African Negro or the aforesaid primordial black stock.

In looking into the subject, we find that, since the dawn of history, men have domesticated and made use of many more mammals than birds; in fact, we have seen that comparatively few of the latter have been domesticated, and these have been to supply us with food, as the various fowls which are, together with their eggs, served upon our tables; others to help out our pastimes, as certain species of falcons used in hunting, and still others used in fishing, as cormorants. Further, a vast number of cage birds, only a few of which have changed to any marked degree in captivity, such as the canary and others, and a few more for special purposes.

On the other hand, the list of domesticated mammals is indeed a long one, and in most instances, through breeding and artificial selection, the majority of the genera and species bear but very slight resemblance to members of the ancestral stock. For example, a greyhound and a French poodle, though both dogs, are very diverse-looking animals, while neither of them in any way resemble the members of the genus of wild dogs which, centuries ago, were their common ancestors.

Besides dogs, we have other mammals domesticated which, including those dogs kept and bred as pets,

represent a very large proportion of the genera of the world's existing mammalian fauna. These embrace, including the aforesaid canines, many kinds of cats (*Felidae*), one of which is the cheeta, used in hunting; bears and certain monkeys; some of the racoon family; the ferret and one or two of its kin; rabbits; squirrels; guinea-pigs (cavies); rats and mice (pet albinos); cattle; sheep; goats; deer of several genera; camels; llamas, pacos, vicunas, etc.; horses, asses, etc.; elephants; swine, and a number of others in various parts of the world—the whole making a list altogether too extensive to cite here in detail.

Some of these mammals have changed but little in the past ages, while others, such as the dogs exemplified above, might, without violence, now be placed in *different genera* from those in which their ferine relatives are retained. In many instances, the descendants are now to be reckoned as entirely new species, and would be so considered by zoölogists were they to be found in a wild state in nature. For example, were all the "lop-eared rabbits" in the world gotten together and given their freedom in some part of the world uninhabited by man, and they did not change, in their new habitat, with respect to their *structure*, however much they might do so with respect to their *habits*, within the course of a century, one may be well assured that, were a mammalogist of the future to discover these animals in the region where they had previously been liberated—believing them to be wild forms that had never been domesticated—he would very promptly describe those lop-eared rabbits as a *new species*, and very probably create a new genus for them.

To appreciate this point thoroughly, one should read what Darwin has given us upon it in Chapter IV of his "Animals and Plants under Domestication." Over half a century ago he collected a perfect mass of valuable information upon this very subject, and he touched on the question of the lop-eared and the half lop-eared rabbits in particular.

Turning to the swine, it is now a well-recognized fact that all of our domesticated breeds of pigs—and there are a good many of them—are descendants of the common wild boar and some of its congeners, and yet how wide are many of the gaps now standing between not a few of the species—for they are "good species," domestication to the contrary; while in some they have become so modified—that is, the tame breeds—that they now form new genera.

There is in all probability just as much difference between a peccary and a wild boar as there is between the latter and a specimen of the domesticated hog; while all three are very distinctly different from that remarkable representative of this family, the masked pig of Japan.

Up to this time, no record has been discovered that informs us with accuracy as to when wild boars were first domesticated, and we can only say that it is a fact of ancient time. We have authenticated records carrying us back 5,000 years on this question; pigs were domesticated in China at that early time and long before, there is every reason to believe.

Were we to collect what has been published in all languages, up to the present time, on the horse and its allies, we would find that it would aggregate a very large library. No mammal has had greater attention paid to it in this way, nor having its history more elaborately built up in various ways at the present time than the horse.

Further, there are few mammals—indeed, we may doubt if there be any—the knowledge of which is more fully encompassed than this animal and its numerous congeners. They are the only mammals now in existence which present the curious anomaly of having each of the four limbs terminating as a single, enormously developed toe, with a thick, immense nail, upon which its owner treads.

Far back in geologic time, the earliest ancestors of horses were no bigger than foxes, and possessed several functional toes on each foot, three on each hind-foot and four on each fore-foot. These occur in the lowest Eocene, and doubtless were preceded by still smaller forms, which, among other things, were characterized by the normal pentadactylous on all the limbs. (Basal Eocene, 3,000,000 years ago). So it must have been at least two millions of years ago—and perhaps more—since the Eocene horses flourished in this country, and of these we have fossil remains. Darwin says that the "history of the modern horse is lost in antiquity."

From the standpoint of the comparative anatomist, these great, bulky descendants, now living with us, of those pristine forms of fox-like proportions are structurally, as hinted in a former paragraph, more anomalous than those dwarf-like Hyracotheres.

Prjevalsky's horse and the Celtic horse probably now stand among the most remarkable of existing species. Zebras are only curious from the fact that they present such unusual markings, while none of the asses are peculiar.[1]

At one time, Mr. E. H. Bostock of the Glasgow Hippodrome owned some most anomalous or, indeed, abnormal, equines, the like of which—and of these examples in particular—it has not been my fortune to have seen. (See illustrations). Of these, "White Wings" is said to be the most beautiful horse alive. It is not known to me whether this magnificent creature is still in existence. He had a rival in "Linus," another horse that could boast of a double mane thirteen feet in length on either side, and a tail of seventeen feet.

Mr. Bostock likewise owned a hairless mare with a skin resembling India-rubber ("Wild Nell"); also extraordinary donkeys, one a tiny dwarf and another a ponderous giant, the latter being outstripped, however, by "Dinah," a creature having a height of twenty-one hands!

A midget named "Dot" was the smallest horse, being only a few hands high; while "Columbus" was an immense horse of gigantic proportions.

We find many albinos among horses, and occasionally one exhibiting peculiar markings.[2]

When we come to study the histories, both modern and geologic, of cattle, sheep and goats, and other domesticated mammals mentioned above, it forms a series of chapters quite similar to what has just been set forth for the horse. There are, in each case, their *extinct* ancestors, of which we have found and possess more or less perfect fossil remains, carrying them back to varying periods of geologic history; there are the early and meagre accounts that have come down to us, which, as a rule, run back and are lost in antiquity and in the backward-extending, vanishing lines of the ancients that, beyond this again, merge into the misty and the unrecorded of prehistoric times.

During these long stretches of the past centuries, men have bred many kinds of strange-appearing cattle, sheep and goats. Some have widely varied with respect to the wild stock from whence they were derived; others have remained fairly staple. Usually the two main objects have been to increase the weight and food-value of the breed; sometimes it has been the aim to improve the milking-capacity; while occasionally, in the case of some cattle, the draught qualities have been taken into consideration.

In the case of sheep, the wool-producing capacity has often been uppermost in mind with the skilled breeders, and often to enhance the value of the breed's mutton.

During the long periods that these trials were conducted by every race all over the world where breed improvement was undertaken, for untold thousands of generations of people, by breeders exhibiting all degrees of skill and intelligence, and millions of cases in history where the crossing was all of the nature of mere chance, it is not to be wondered at that some very anomalous animals were reproduced from time to time. This is just what did take place, and many of these anomalies may be seen today.

Among the very large array of breeds of domestic cattle now known to those having knowledge of such matters, we may note the remarkable Hungarian cattle, animals that possess horns measuring over 5 feet from tip to tip, and the high-shouldered Podolian cattle. In Paraguay they have a breed with *reversed hair*, and the *chicos* of another part of South America have *straight, vertical* horns which are very large at their bases.

Writing on this subject, Darwin says: "A monstrous breed, called niatas or natas, of which I saw two small herds on the northern bank of the Plata, is so remarkable as to deserve a fuller description. This breed bears the same relation to other breeds, as bull or pug dogs do to other dogs, or as improved pigs, according to H. von Nathusius, do to common pigs. Rutimeyer believes that these cattle belong to the primigenius type. The forehead is very short and broad, with the nasal end of the skull, together with the whole plane of the upper molar teeth, curved upwards. The lower jaw projects beyond the upper, and has a corresponding upward curvature. It is an interesting fact that an almost similar conformation characterizes, as I have been informed by Dr. Falconer, the extinct and gigantic Sivatherium of India, and is not known in any other ruminant. The upper lip is much drawn back, the nostrils are seated high up and are widely open, the eyes project outward, and the horns are large. In walking the head is carried low, and the neck is short. The hind legs appear to be longer, compared with the front legs, than is usual. The exposed incisor teeth, the short head and upturned nostrils, give these cattle the most ludicrous, self-confident air of defiance."

In 1829 there was a white bull exhibited in London that had a *mane*.[3]

All our domestic sheep—and there are many breeds of them—are descended from two or three ferine species, still existing in various parts of the world. Some extraordinary anomalies occur among the domesticated ones, as has just been seen with respect to cattle.

There is the "fat-tailed sheep," a degenerate species with an enormous accumulation of fat on the rump, and, as a matter of fact, the tail is in a rudimentary condition. An Angola sheep has a remarkably *long tail*, and big lumps of fat in its occiput and below the jaws. We also find sheep greatly varying in the matter of their *horns*, some kinds having a multiplicity of these appendages. Those seen by me many years ago in New Mexico, usually possessed four horns or a pair on each side of the head. One of this kind furnished a most interesting skull purchased by me from an Indian. This is now in the collections of the Wistar Institute of Anatomy of Philadelphia.

Sheep of this kind have had as many as eight horns on their heads; these always arise from the *frontal* bones and the breed having them are noted for the coarseness of their fleece, which is long and more or less straight. Other breeds of sheep possess *four* teats, which is quite anomalous as the wild species present but a pair.

Darwin says: "In some few instances new breeds have suddenly originated; thus, in 1917, a ram-lamb was born in Massachusetts, having short, crooked legs and a long back, like a turnspit dog. From this one lamb the *otter* or *ancom* semi-monstrous breed was raised; as these sheep could not leap over the fences, it was thought that they would be valuable; but they have been supplanted by merinos, and thus exterminated."

There is a very large literature on the breeds of domesticated sheep, and anomalies of all sorts have been described and figured. Abnormalities occur here as among other animals; it is not uncommon to meet with "double-headed" sheep, and other teretological cases; these do not concern us here.

Our domesticated goats are derived from ferine species found in Asia and India. They were commoner in Switzerland during the Stone Age than sheep, and no change of any note has taken place in them since. At the present writing, a very large number of domesticated breeds of goats are to be met with in various quarters of the globe, and all sorts of anomalies are found. There is a Mauritian breed with *immense ears*, often measuring some twenty inches in length. Others have their teats so long that they drag along the ground. This has been produced by artificial selection and breeding from man's desire to secure "good milkers." There is an Indian breed in which the horns of the two sexes are entirely different.

Some domesticated goats present extraordinary anatomical characters; for example, in the Dúgú breed the intestines exhibit remarkable anomalies. Hodgson measured them in one individual where he found a case of 13 inches in length, and the small intestine 36 inches!

A writer at hand says: "The dividing-line between the sheep and goats is very indistinct, some differences are of general application. The goats are distinguished by the unpleasant "hircine" odor of the males, and by beards on the chins of the same sex, by the absence of glands in the hind feet, which sheep possess, and by certain variations in the formation of the skulls." As to the odor of the males among domesticated goats, mentioned by this writer, there is one breed known in which it has been eliminated by crossing.[4]

In discussing the evolution and origin of the human chin recently, in the London *Telegraph*, Sir Ray Lankester invited attention to some remarkable anomalies in certain domesticated animals, a reference to which may fittingly close the present chapter. This distinguished scientist informs us that "In breeds of horses [that possess] long limbs [they] are accompanied by an elongated head. White cats which have blue eyes and are of the male sex are almost invariably deaf. White sheep and white pigs are poisoned by certain plants in their food, although dark specimens escape injury. Hairless dogs have imperfect teeth. . . and, further on he invites attention to the pair of bony processes or small 'horns' on the frontal bone of certain horses."

Sir Ray's article was largely reproduced with illustrations in *Current Opinion* for July, 1913.

[TO BE CONTINUED]

[1]See the excellent account of "The Multiple Origin of Horses and Ponies" by Dr. J. Cossar Ewart, F.R.S. Trans. Highland and Agricultural Society of Scotland, Vol. XVI, 1904. This is abridged and reprinted (with beautiful figures) in the Smithsonian Report of 1904, pp. 437–455, Government Printing Office, 1905, a copy of which has been kindly presented me by Mr. Fred W. Hodge of the Bureau of American Ethnology.

[2]Shufeldt, R.W., "Coloration of Horses and their Allies." *The Horseman and Spirit of the Times*. March 1, 1910. pp. 134, 135. Illustrated

[3]Harvey, London's Magazine of Nat. History, Vol. 1, 1829, p. 113. The animal is figured here.

[4]Clark, G. Ann. and Mag. of Nat. Hist., Vol. II (2d series). 1848, p. 363.

# Electro-Culture of Crops*

## A Review of Recent Developments

The application of electric discharge to crop production is at the present time of more than purely technical interest. From the national aspect the introduction of an auxiliary aid to crop production by which the yield per given area may be increased is of even greater importance than the putting of a larger acreage under cultivation. It is from this point of view, as well as from the engineering side, that the new movement for the adoption of methods of electro-culture is attracting attention. Much, however, yet remains to be done if the efforts of workers in this field are to be attended with success, and the long period of marking time terminated.

### CORRELATION OF INFORMATION

It is a somewhat remarkable fact, considering that it is nearly two centuries since attention was first directed to the possible advantages arising from the application of electricity to plant and crop growth, and 27 years since Lemstrom revived interest in a neglected branch of electrical science, that the progress made has not been great. There seems to have been an excessive tendency for workers to shut themselves up in watertight compartments, and even today, although there are notable exceptions, there is in evidence a desire among many workers to refrain from any publicity regarding methods adopted or results achieved. Scientific caution and the avoidance of premature publication are commendable enough, but the experimental crops grown by electrical discharge methods during the past season in the Liverpool, Chester, Hereford, Pershore, Peckforton, Winchester, Wisley, Rothamsted, Dumfries and Cardiff districts, among others, must have yielded much valuable information concerning methods of using the current and the adaptability of the different types of apparatus to the purpose in view, which would conduce to further advance were it generally available to interested workers.

### SUGGESTED COMMITTEE

There is room for the Imperial College of Science, through the Botanical Section of which the grant made for experimental work in electro-culture is being expended, to take steps for coördinating the work in hand and for uniting engineers, manufacturers, scientific workers, and agriculturists in a common effort for the solution of the problems involved. There have, it is understood, been one or two consultations between members of the staff of the Imperial College representing the Development Commissioners and municipal authorities who are taking an interest in the extension of the application of electricity in agricultural work, including electro-culture, but it can scarcely be claimed that the necessary degree of coöperation has yet been established. Perhaps the best solution would be for the Board of Agriculture to appoint a committee on which would be represented the Incorporated Municipal Electrical Association and the Board of Agriculture, with Professor Blackman and Mr. Jorgensen, who have been charged with the conduct of research work on behalf of the Imperial College, an independent representative of farming interests, a pure physicist, and a manufacturer of electrical apparatus. If a committee of this character were appointed, and the lines of investigation settled by all the interests involved, there would be assurance that the many points on which information is desired would be attacked in a spirit which should yield results at an early date. Before the average farmer can be induced to spend money in the purchase of electrical apparatus he requires an authoritative statement as to its utility and the way in which it should be employed. A report from a committee of the character indicated, dealing with the financial as well as the technical aspects of the matter, would carry weight and serve to settle a matter which has been at issue for far too long a period.

### PIONEER WORK

The first recorded work on the subject was apparently done in Great Britain, to which country the lead is, it is hoped, again reverting. It was about 1746 that one Maimbury is said to have experimented in Scotland with a frictional machine. On his work followed that of the Abbé Nollet in 1750. It was 20 years later that Jallabert, who, like Nollet, used current produced by the crude means then at the disposal of experimenters, carried out an investigation at Geneva. To him succeeded the Abbé Berthelon, whose work was done in about 1783. Between this date and the end of the 18th century a number of investigations, in which atmospheric electricity was used, were conducted by various workers, some of whom made painstaking records of their work. One of the best known of these was Professor G. B. Beccaria, of Turin, who met with some success in his attempts to stimulate plant growth. A critical period in the history of the subject was the careful research made by the Dutch physicist Ingenhousz in 1800. He also used atmospheric electricity, but it is probable that the intensities employed were too high, and the negative results obtained, owing to the fame the experimenter held as a plant physiologist, delayed progress for a considerable period.

It was not until about 1840 that interest in the subject revived under the stimulus of encouragement offered by the Highland and Agricultural Society. William Sturgeon, who was lecturer in National Philosophy at the Manchester Institute of Science, described in the *Journal* of that Society a series of experiments carried out under his direction. Several areas, one in Trafford Park, another at Didsbury, and a third at Kirkby Lonsdale, were planted out for electro-culture. His results were somewhat variable. Other workers also gave attention to the subject, but it was about this period that the advantages of using artificial fertilizers began to be made known through the work of Sir John Lawes, and the obvious benefits to be thus derived quite overshadowed the problematical gains from the employment of electric discharge, and progress was again retarded.

### LEMSTROM AND HIS SUCCESSORS

Nothing further of importance appears to have been done until the advent of Professor Lemstrom, who began to work at the subject in 1885. His interest in the application of electricity to crop growth arose out of impressions gained during a visit to the Arctic Circle as to the influence of atmospheric electricity on vegetation, and he experimented on a considerable scale in Finland, Germany, and England, his researches giving what has been generally accepted as proof that in some instances, under certain conditions which are still the subject of inquiry, electric discharge has a remarkable effect on the growth of vegetables, cereals and fruit. Lemstrom's method of discharging the current through a wire network erected over the plants which were to be the subject of experiment has been followed by all subsequent workers, although naturally the design and arrangement of the wires have been modified, and other means of generating the current than the influence machine used by Lemstrom adopted.

Interest in the subject has never since abated in scientific circles, although the cooperation of agriculturists as a body has still to be secured. Experiments designed for the direct utilization of atmospheric electricity were conducted by Mr. E. H. Cook, using the discharge from the negative pole of a Wimshurst machine, about 1898, and Dr. H. G. Dorser, an American workers, who employed a Tesla alternating discharger, claims to have given demonstration of the belief generally held that the discharge acts on the aerial portion of the plant and not through the soil. Excellent work has been done during the past few years by Professor J. H. Priestley, first at Bristol and afterwards at Leeds, and by Mr. Jorgensen, who was his colleague in much of the work.

It was, however, the Lemstrom method which held the field until Mr. J. E. Newman, who has been closely associated with the developments of the past 12 years, replaced the influence machine by the Lodge system of generating high-tension electricity. Under this system alternating current is generated by an induction coil, one terminal of the secondary being connected to earth and the other to the discharge network through a series of Lodge rectifiers. It is this apparatus, modified in detail as the result of experience, that has until now been generally employed.

### SOME RESULTS ACHIEVED

With this source of energy and with a working pressure ranging up to 120,000 volts, charging a wire network which in the latest practice is spaced 10 yards apart at a height of 15 feet above the ground, Mr. Newman, in work at Bristol, Evesham, and Pershore, has obtained gains from wheat up to 39 per cent, with barley 5 per cent, strawberries 36 per cent, cucumbers 17 per cent, broad beans *nil*, and mangolds 25 per cent. This year the same worker has obtained on his farm at Pershore an increase of 33 per cent in the wheat yield as compared with a control area, and a satisfactory result with mangolds. The gain in wheat is due to a better filling of the ears and heavier grain. He intends to lay down plant to supply electric discharge to 100 acres next season, and as he is an electrical engineer as well as an agriculturist his work will be followed with much interest. At Lincluden, near Dumfries, where Miss Dudgeon has been growing experimental crops for some years past, the report on last season's working, which has been made by Professor V. H. Blackman and Mr. Jorgensen, refers to an increased yield from oats of 49 per cent in grain and 88 per cent in straw, thus confirming the experience of earlier years. These are the chief definite results available of recent experiments. At Liverpool the crop selected for the past season's tests were garden produce and oats and the experiments, which were conducted by the corporation and their electrical department, are said to have given proof of the beneficial effects of the electrical discharge.

At Hereford, under the direction of Mr. W. T. Kerr, 60 acres are to be planted for test purposes, and at Chester three separate areas of 1½ acres, 10 acres, and 14 acres have been allocated by the electrical engineer of the city, Mr. S. E. Britton, for experimental work with various types of apparatus.

### PROBLEMS TO BE SOLVED

The projected additions to areas under cultivation, together with the proposed tests of the various types of generators and equipment, should lead to the accumulation of data which will throw light on the primary questions to be solved. These refer to the manner in which the electric discharge acts on growing crops, which is a subject for the plant physiologists from whom a committee to deal with the matter has just been formed; to the best method of utilizing the electric current; and to the kinds of crop to which the services of this adjunct can be applied with the greatest advantage. Much depends on the replies to these questions. Even when satisfactory answers have been obtained, there is much to be done by electric supply authorities. There can be no marked extension of the use of electricity in agriculture, whether for stimulating plant growth or other purposes, until electric supply authorities have carried their mains into all important farming areas.

*Engineering Supplement of the *London Times*.

## Chlorophyll in Animals

Dr. P. P. Podjapolsky has for some years been investigating the occurrence of chlorophyll in various animals ("On Chlorophyll in Animals and on the Fate of Chlorophyll in the Animal Organism," Moscow, 1916). He finds that a green pigment, giving an absorption band between the lines B and C of the spectrum can be extracted from the wings and elytra of a number of Orthoptera, and from the skin of some frogs (*Rana esculenta, Hyla orborea*). As the band described coincides exactly with that shown by an extract of a green leaf, such as that of Robinia, he concludes that chlorophyll itself is present in these animals. He suggests that chlorophyll in animals may be produced *de novo* by the animal, or it may be derived from ingested plant material escaping digestion wholly or in part, or it may be the result of symbiosis. He states also that the chlorophyll band between B and C may be observed in spring in the bile of grain-fed herbivorous animals, such as cows and sheep. Dr. Podjapolsky has been able to recognize not only chlorophyll but also bile pigment in a pyridine extract of the contents of the stomach of the mammoth discovered in a glacier at Beriosov, and now preserved at Petrograd. From the position of the animal it would seem to have slipped backwards on the ice, and its violent efforts to recover itself probably caused a regurgitation of bile into the stomach. It is surprising that the author makes no attempt to explain his use of the term chlorophyll, and gives no reference to the work of Willstätter, who has, of course, clearly shown that crude chlorophyll contains four distinct pigments, two green and two yellow.—*Nature.*

## Chemical Method of Detecting Deterioration of Wool

An attempt to evaluate wool from a chemical standpoint was made, based on a determination of the proportion of the total nitrogen which it yielded to solvents. The procedure consisted in treating 0.5 grm. of wool with 40 cc. of water, 50 cc. of 1 per cent hydrogen peroxide solution, and 10 cc. of N/2 potassium hydroxide for three days, after which the nitrogen in an aliquot portion of the solution was determined and thence the total dissolved nitrogen calculated as a percentage of the nitrogen content of the original wool. In wool that had been exposed for four months to sunlight, a much higher proportion (45-50 per cent) of the total nitrogen was soluble than in non-illuminated specimens (11-13 per cent). In the case of dyed wool this change due to light, though still noticeable, was greatly retarded.—Note from *Journ. Soc. Chem. Ind.* in an article in Z. angew. Chem., by O. Sauer.

Photos by the Gilliams Service

Few people would imagine that every one of these clocks, now undergoing repair, had been cast out with household waste

# Junk Is America's Richest War Bride

## The Result of Amazing Wastefulness

### By James Anderson

WAR brides are a topic of very general conversation these days, but few of us, however, realize that the richest of these brides is named Junk.

While junk stock may not be quoted on the Exchange or on the curb in New York, at the same time it is not only at present the most stable but is also bound to continue so far some years after the war is over.

As although when peace comes something like a permanent level is to be expected, at the same time this level will be several hundred per cent above that of the days before the war converted the American scrap heap into a treasure heap.

Before the war the gross business transacted by the junk dealers of America probably averaged about $100,000,000. Recently at the annual convention of waste material dealers held in New York, it was announced that the combined business of the junk dealers of America was now more than $1,000,000,000 a year.

In other words, old rags, bones, old iron and scrap metals, waste paper and other like materials have become most important commodities.

The makers of paper, shoddy and sheet roofings are beseeching our women at the present time to save old newspapers, books, magazines, woolen and cotton rags, pasteboard, burlap and bags, all of which accumulate rapidly in every household. Other manufacturers no less eagerly are imploring them to save waste metal and rubber.

Previous to the outbreak of the war in Europe, while it cannot be said that every American housewife disdained to save her old papers or rags, a goodly portion did. This apparent carelessness on their part was not without reason. They had found this economy to be practically profitless.

During the civil war old rags, papers and household waste in general, were, just as now, at a premium, and everyone kept a scrap bag or basket into which was cast the odds and ends. But after the war, with the introduction of new methods in paper making, such as the use of woodpulp and fibre, women found their rags and paper dwindled in value year by year until the returns from saving them were so small there no longer existed any incentive to do so. For we have not yet learned to think very seriously of the saving of pennies.

With the women of the countries of Europe, however, it is a very different story. They were schooled by their mothers in painstaking household economy in every possible direction, and in turn teach the same to their daughters. In the old world every copper counts, and for each piece of silver that can be made there is a special urgency. So, despite low prices, the housewives of the Continent scrupulously saved and regularly sold their old rags, paper, rubber and metals.

It was for these reasons the failure on the part of American women to save their waste and the strict economy practiced by their European sisters, that prior to the outbreak of armed strife on the other side, thousands of tons of rags and old papers yearly were imported. More than $2,000,000 worth of just one sort of rags, required in the making of a particularly fine grade of writing paper were shipped here every year.

Sorting rags, white, colored, woolen and linen are put in different piles and baled separately as they fetch varied prices

Strangely enough, all connected with this international economic see-saw seemed perfectly contented. The paper makers uttered no word of complaint; they were receiving their supplies at a satisfactory price with clock-like regularity. The women of Europe smiled placidly as they realized sums which appeared tidy to them, by disposing of their accumulations of household waste. And the women of this country, that is, most of them, not caring particularly where or how the mills obtained their paper making supplies, complacently threw their rags into the rubbish pile and blissfully used staggering quantities of paper and cardboard, which after serving its original purpose they started the kitchen fires with. In other words, actually as well as metaphorically, they were burning the candle at both ends.

And then suddenly with a world reverberating crash, the see-saw fell. Europe went to war. Supplies of all sorts were needed at home to staunch the flow of blood from many gaping wounds and a strict embargo was placed on old rags and paper by the various countries.

Almost immediately the ravenous maws and hoppers of our paper mills yawned emptily. There were scant supplies available to feed to them. The price of all waste material on the American market went soaring. Soon, some mills were forced to pay eight times the former price for rags or else shut down. Waste that sold for half a cent a pound jumped to four cents; and the mill owners greedily bought all they could at that figure.

The natural consequence was that the business of buying and selling waste paper, once a drug on the market, assumed a position of real importance in this country until it now averaged about $100,000 a month for every million of population.

Every one is now saving their waste, and second hand book dealers have even sometimes found it profitable to tear covers off books and sell them for waste paper. School children have made thousands of dollars by collecting and selling waste paper, the pupils of the grade schools of Des Moines, Ia., having sold $2,000 worth of waste paper collected during one week.

What has happened in reference to the increased value of waste paper has also occurred with all other lines of junk.

When scrap iron first began its dizzy climb it nestled around the $2 mark, but within a year it was selling at $10 and $12 a ton, with an unlimited demand. Old copper, brass, aluminum, zinc, electrotype and other metals jumped skyward, factories utilizing these materials being unable to get enough to meet the demand. The great railroads engaged in the junk business themselves on a tremendous scale. In one month 30,000 tons of old iron was dumped into the St. Louis iron market by railroads entering that city, yet there were still cries for more.

Photos by the Gilliams Service

**This old tailor is an expert in remaking junk-heap clothing**

**Restoring old furniture which had been cast out on the refuse heap**

Not the least interesting side of the junk or waste material business has been the recent addition of a new side line, that of buying and scrapping old motor cars. The enormous production of motor cars in the last ten years has of course been attended by depreciation of the usefulness of hundreds of thousands of old cars. The market for these old cars has grown until it is now keeping pace with the growth of the motor industry. There are in various parts of the United States large concerns which specialize in the buying and wrecking of old cars. The business is worth many millions of dollars a year.

There is a possibility that old tin cans may become a marketable commodity for the junk dealer before long. The tin can shortage of last summer turned the attention of the waste material kings to this source of raw material, and in many cities experiments were made to determine the practicability of collecting and melting the huge quantities of tin cans allowed to go to waste.

Another year of such conditions as those which have been brought on by the war will undoubtedly result in a price being set upon the old tin can, and it will become well worth while for the youngsters of the land to turn their attention to the collecting of cans for business purposes.

The big profits to be made out of waste have naturally attracted the attention of some very astute business men to the trade of the despised junk man, and in every city in the United States thousands of men are now engaged in this business who would have looked upon it with disdain before the war.

As to the exact number so employed today in the country as a whole no estimate has been made but in New York City today there are something over 150 firms engaged in gathering and selling waste paper alone. At a very conservative estimate 40,000 workers—push cart men, drivers, sorters, buyers, experts are engaged in this industry in the greater city. More than 100,000 tons of waste paper is collected and shipped from the city every week, 5,200,000 tons every year.

These waste paper kings, who are making fortunes from the industry, do not have their offices in skyscrapers along Broadway, and you won't find any of them in any of the buildings around Wall Street.

If you are looking for the factory of a waste paper king, go down along the water front and pick out the worst ramshackle buildings to be found there. If one of the kings of the new industry is operating in that neighborhood, you will find his throne room in the building that seems nearest to the point of tumbling down.

Some of the junk dealers do not have any warehouse at all. Take the case of an Iowa junkman, Tom Robinson, whose rickety wagon and ancient horse were a familiar sight in many small towns in the central part of the state.

When the war broke out, and the prices of junk began to soar, instead of selling his stock, Robinson rented a three acre field near his home and invested every cent he could spare in junk. When he had finally accumulated a pile of waste more than forty feet high he sold the entire collection for more than $100,000 and one of his first acts thereafter was to discard his rickety wagon and horse for a seven passenger touring car.

Although we all contribute, few of us seem to have any realization of the enormous amount of still serviceable material we cast into the American junk heap quite apart from rags, waste paper and old bottles.

Before the war the vast majority of this so-called household refuse went to its grave never to be utilized in its original form again, but the recent very sharp raise in the price of clothing, boots, shoes, furniture and in fact most everything we wear or use in our homes has put a value on second-hand material of this nature it never had before and has created an incentive for John the junkman to carefully rescue it.

Take discarded shoes, these are now all salvaged even when in such a condition that it would seem that nothing

**Baling waste paper and rags for shipment to the mills**

short of a miracle could restore them, yet stage after stage they are, by careful workers, quickly remade into serviceable footwear, soft and strong. First they are soaked in a mixture which renders the leather pliable as ever. Then they are scrubbed and rubbed and patched and soles or heels put on where required, after which they are ready for the stores of the second hand dealers who have recently built up a thriving business in such goods.

**Making junk-pile shoes again serviceable**

The same thing obtains with clothing, tattered, torn and often mud stained, it first passes through a disinfecting bath and is carefully dried and then taken in hand by a small army of excellent tailors who, with wonderful cleverness and ingenuity, remake it. After, which, like the shoes, it gravitates to the second-hand dealers who have many patrons for such wearables among the poorer folks who cannot afford to pay the present high prices for new clothing.

Again, in recent months, in all our big cities, hospitals have sprung up for wounded junk heap furniture which it is even easier to make over than either shoes or clothing. With amazing skill, expert cabinet makers repair the damage that has been done to it by the wear and tear of long usage. Lost and broken parts are replaced, new springs supplied and marvels in upholstery accomplished and finally it also is as good as new, ready for the second-hand market. Occasionally surprising as it may seem really valuable antique pieces of furniture are cast out in the junk heap on which, when repaired, many dollars are not infrequently realized by the lucky finders. Some of the things which are rescued from the junk pile these days are really remarkable. Take old clocks as an illustration. Because they won't run and fail to tell the time, people instead of sending them to be repaired become tired of them and out they go with the weekly refuse. But that is by no means the end of them, as many are rescued by provident John, repaired by expert clock makers and then resold to ornament and tell the time of day in many humble houses for years to come.

## The Different Methods of Preparing Rubber

A RECORD of observations on the influence of the method of coagulation on the properties of the final rubber. Rubber was separated from preserved latex taken from trees planted in 1898, by (1) evaporation, with subsequent washing of the product; (2) coagulation with acetic acid, followed by washing; (3) evaporation, followed by drying in a vacuum without washing; (4) evaporation, after dialysis of the latex for four days; (5) coagulation with acetic acid after the latex had been dialysed for four days; (6) evaporation after 14 days' dialysis; (7) coagulation with acetic acid after 14 days' dialysis, the product in each of the last four experiments being finally washed and air-dried. The various samples obtained were examined as to their content of moisture, ash, proteins, total matter insoluble in petroleum, and resinous matter; the portion of the acetone extract which was soluble in water was also determined and the viscosity of the benzene solution of each product was measured. It was found that dialysis reduces slightly the proportion of resinous matter and also, as was to be expected, the proportion of mineral matter and water-soluble organic matter. The rubber obtained by evaporation had a higher protein content than the samples prepared by coagulation and was also exceptionally hygroscopic. The viscosity of rubber prepared by evaporation was somewhat lower than that obtained by coagulation, while with the sample obtained by evaporation of the dialyzed latex the reduction in viscosity was still more marked. Reference is also made to other investigations of the above Institute, and it is stated that samples of rubber produced by an electrical method, although of normal composition, have been found to possess remarkable viscosity, speed of vulcanization, and mechanical properties after vulcanization.—From a communication from the Netherlands Government Institute for Advising the Rubber Trade and Industry.

# The Relation of Chemistry and Mechanical Manipulation to the Evolution of the Glass Industry*

By Robert L. Frink

To do more than touch upon the generalities of the subject, would evolve a great amount of data, and lengthy explanations. It would necessitate to present for criticism or ridicule many of the mooted questions which many now consider as fixed and well determined from a practical standpoint, while from a chemical standpoint they must be considered irrational. Therefore I must and will endeavor to deal with those generalities only which show the progress of the glass industry from a mechanical and chemical standpoint, and I will touch only upon those specific conditions and materials that go to make up success or failure in handling, forming and making of glass articles by the processes of today.

If one has access to the information which is upon record in the Patent Office or in memories or can be obtained from personal conversation with some of the older men in the industry, it is astounding to learn that many of our advanced mechanical appliances and means for manipulating glass, were conceived, and in some instances exploited, 50, 60 or more years ago. There is perhaps no instance in the annals of the Patent Office wherein the understanding of the true properties and requirements of glass are set forth in any more definite manner than in the old French patent of Loup, of 1854, wherein Loup has conceived and designed a mechanical device for the producing of cylinders of glass by means of what is at present known as a "bait member." This is lowered into a body of molten glass, withdrawn therefrom, air pressure is supplied within the cylinder thus formed, and then a cylinder is progressively drawn from the molten body. However, Loup recites that the temperature, the specific heat, the expansion and contraction of the glass, and the air within the cylinder are all factors in producing a uniform cylinder of glass, and that composition affects all these factors.

Later Opperman attempted to produce the same result by a considerably different process, using purely mechanical devices throughout to obtain the drawing of the cylinder, the introduction of the air thereto, and the control of the pressure of the air therein. He, however, makes no specific reference to any of the physical properties of the glass, or their effect upon the success or failure of his apparatus to produce the required result.

Later Sievert, Lubbers, George and Shortle, and others, besides myself, attempted the production of glass in this manner, and at a still later date, in 1904, the American Window Glass Company took up Lubbers' conception, a somewhat crude but nevertheless demonstrative device, and exploited same, introducing at Alexandria, Ind., a full equipment for the production of window glass. This process comprised the lowering into a bath of glass a pipe similar to the ordinary glassblower's pipe, although larger and heavier, withdrawing this pipe from the bath of glass, introducing the air through the pipe member, and controlling the air pressure in an manner as to blow out and form a cylinder of glass.

The preliminary results obtained in this operation appeared to be perfect, so far as the forming of the cylinder was concerned, and the officers of this company had so much confidence in the results that they installed these machines in a number of their plants. Certain modifications and improvements were added whereby it was deemed that the cost of manufacture, maintenance and upkeep would be reduced below that of the original plant. It was found, however, that under practical operating conditions there were other factors, hidden ones, which greatly affected the amount of glass which could be delivered to the warehouse, and that it was quite a different proposition to make cylinders of glass in quantities, sizes and thickness, and cut them into lengths, flatten them, and again cut them into sheets the quality and perfectness of which would permit of their being placed upon the market. A cylinder might be made that was perfect and drawn perhaps to a length of 20 feet or more, but when it was attempted to lower this cylinder, cut it up into lengths or flatten it into flat panes of glass, breakage would occur, and this breakage sometimes would be in excess of 80 per cent of the total production. At times it amounted to as much as 90 per cent of the possible production.

The cause of this breakage seemed entirely obscure to the most practical and successful glassworkers and glassmakers, and for a time it seemed as though the prediction of old glassworkers was about to prove true, namely that "the devil resides in glass and man can not take him out." However, as is usually the case when the practical "rule-of-thumb" man meets unknown difficulties, he turns to science for assistance, and by the combination of logical theory with methodical practice the problem is solved.

It was found that these breakages occurred as a result of the differences which existed in the composition of the glass comprising an individual cylinder, and that the operators were seriously hampered by the lack of information concerning the correct temperature to be used, concerning the difference of expansion and contraction between the metal forming the bait and the glass, concerning the effect of the chemical composition of the glass and the chemical reactions caused by the conditions of operation of the furnaces, namely, temperature, fire conditions, quantity of material melted or moved through the furnace, and the action of combustion gases.

After lengthy investigations had been conducted and these conditions had been determined, and the chemical and physical properties of glass had also been investigated, many of the early difficulties were overcome, and the process of mechanically forming glass cylinders became clear and much simplified, and today stands as one of the foremost successful inventions of the age, although this very same process and the principles involved therein were conceived and attempted by Loup in 1854. Loup might have been successful in accomplishing what is accomplished today had he been in a position to command the results of research and the benefit of the progress which has been attained in our present-day chemical industries, and had he been able to get the financial assistance, whereby he could have worked out the conceptions set forth in the preamble of his patent application. For therein he hinted at or directly stated that the primary factors which govern the sequence and method of producing glass cylinders. All attempts prior to 1904 unquestionably failed because of the lack of knowledge of the material that the experimenters were working with, its mechanical constitution and means of controlling such constitution.

In 1882 Clark, and subsequently Schulze-Berge, Sievert, Dolan, George and Shortle, Fourcault, Colburn and I attempted making glass in sheet form by withdrawing a sheet of glass from a bath of molten glass, or by flowing a stream of metal in sheet form over a weir or dam-like aperature, or by forcing it through an aperature. Even Mr. Edison has attempted the production of sheet glass in this form, and to this day it is still being attempted. Vast sums of money have been expended in an endeavor to produce a sheet of glass uniform in thickness and having plane surfaces, but all attempts so far have been commercial failures, and I firmly believe for no other cause than our lack of knowledge concerning chemical and physical control of those factors which cooperate to produce a homogeneous glass.

In 1903 I produced sheets of glass from 0.003 inch to ¾ inch in thickness, which appeared to be perfect when entering the annealing oven and coming from the forming device, or before they had cooled to a temperature of less than 250 deg. C. But below this temperature they would begin to warp and get distorted in a manner which made them entirely unfit for commercial use. It has been said that there is one sheet machine on which there has been over a million dollars expended in an endeavor to produce a sheet of glass directly from the the bath of molten glass, but failure has as yet been the only result, due entirely to "warping" as it is called, and to lack of homogeneity.

Other factors which have been a great bane to the sheet glass manufacturers are the mottled appearance of the glass and the difficulty in producing glass which can be placed into windows and retain its surface luster or be free from "fading" as it is termed. This fading is in fact a disintegration or delinquence of the surface due to absorption or the chemical effects of gases or moisture coming in contact with the surface of the glass and combining with the constituents thereof.

In the making of pressed ware, *i. e.*, tumblers, jelly dishes, cake dishes, punch bowls, etc., much difficulty is experienced in obtaining a glass which can be manipulated in sufficient quantities in an iron mold and pressed out in the desired form, so as to obtain the tone configuration of the mold without showing imperfections. In recent years, since the advent of the pressing and blowing machines for the making of bottles, milk jars, table ware, fruit jars, etc., many of the difficulties before mentioned have presented themselves. That is to say, the machine may be of good design and produce ware of commercially perfect shape from the molds, but in subsequent operations to which this ware is subjected, many sources of loss occur. In the making of goblets, shades, etc., after the article has been formed from the molten mass, and either cooled to atmospheric temperature or reduced in temperature to 100 or more degrees below the solidifying point, it must be again subjected to the impinging heat of a flame to round the edges or permit a reshaping of the piece, and this treatment will often cause the ware to fly to pieces. Or perhaps the ware may be subjected to a grinding operation, and the abrasive effect of the wheel or stone or perhaps the rise of temperature occasioned by the grinding will produce breakage. In the case of milk jars, fruit jars, or bottles subjected to sterilizing or pasteurizing operations, the sudden heating or cooling of the same would cause them to break and possibly incur the loss of the liquid placed in them, and all of these conditions are due to heterogeneity.

Perhaps one of the greatest banes of the electric lamp manufacturer is the breakage of his stems, or the joints between the stem and the bulb, or possibly the imperfect sealing of the leading-in wires. Again, another defect which he has to contend with and which is due to lack of chemical control, is the smutting of the bulbs, this being again a chemical effect upon the surface of the glass caused by the contact of gases which attack the glass and reduce the lead therein.

I have gone to some length in enumerating some of the principal causes of loss in production and lack of satisfaction as to quality in the different cruder and grosser branches of the glass industry, in which it has been thought inadvisable, or at least unprofitable, to employ a scientist or chemist for the purpose of investigating and determining the causes of these losses. This is due, to a great extent, to the fact that the glass manufacturers and the men in control of the glass factories are, in the majority of cases, men who have grown up in the business and have been compelled to devote their time to the practical problems as they saw them and had no time to investigate the possibilities of scientific research.

As a matter of fact, there are a great many so-called first-class glassmakers, and men who are responsible for large productions and finest quality of ware, whose knowledge of the constitution of glass begins and ends the moment when the material enters the furnace, and as a matter of fact many of them still believe that glass is composed of sand which has been reduced to a molten state by being placed in a mixture with such ingredients as lime, soda, potash, feldspar, fluorspar, cryolite, antimony, zinc oxide, borax, or whatever else their batch formula may call for, and that after it has been subjected to fire all of the ingredients with the exception of sand go up the stack. It is only the more progressive individuals who have studied this matter, who have benefitted by research, and who have any true conception of the actual composition of the glasses that they are making. However, even they, in many instances, have no true knowledge as to the properties given to the glass by the materials they use, and in fact there is but little actual specific knowledge available.

It is true that in Europe, and in recent years also in this country, there has been considerable progress in the making of certain glasses for special purposes, and we owe much to Guignand, Bontemps, Schott, Hovestadt, Harcourt, and others, who having contributed greatly to our knowledge of the composition and making of optical glasses manufactured in close pots, or under conditions whereby perfect control could be had of the atmospheric, melting and temperature conditions. But there has been little or nothing done, in a practical way at least, to give us specific information as to the effects of the chemical constituents of glass when the same is made in tank furnaces, in open pots, or under varying fire conditions or how they affect our various processes of manufacture. As I have found by extensive experiments and research, the tensile, crushing and electrical strength, also the fluidity or viscosity of glass can be varied through a wide range by variation of these conditions.

Further, it seems to be pretty well established that in the making of glasses in tank furnaces, the homogeneity of the glass is governed to a considerable extent by the uniformity of fire conditions. However, I

*An address made before the First National Exposition of Chemical Industries in New York City reported in *Metallurgical and Chemical Engineering*.

make bold to state that the chemical constitution of a glass is the more important factor which makes possible the production of a homogeneous glass in a tank furnace. I mean that the relative proportions of the constituents are more important than the actual constituents; that is to say, a glass may be composed of soda, lime and silica only, and unless the proper chemical proportions are maintained we will not get a uniform and homogeneous product under variable fire conditions, while on the other hand other combinations can be used and if the proportions are right, and the fire conditions are properly maintained for such proportions, homogeneity will result. In this, I believe, we have before us one of the most salient problems that affects the greatest number of glass manufacturers.

It is true that for the production of certain classes of articles, like thermometers, measuring vessels, etc., it is necessary to observe uniform and definite composition, in order that the required expansions, heat resisting properties, electrical properties, etc., may be obtained. But for the glass manufacturers who are producing the greatesy tonnage, and the greatest amount of ware in dollars and cents throughout the country today, the vital problem consists of:

What can I do to obtain the greatest amount of melted material for the minimum cost? How can I produce it in finished product for the minimum cost? What will assist me in putting my ware into packages, ready for the market, with minimum breakage or loss?

Right here is where the chemical industry can be of incalculable assistance to the glass industry, for if the manufacturers and operators of our chemical works, who mine, manufacture or sell the raw materials to the glass manufacturers will but put their shoulders to the wheel they will assist in turning the glass manufacturer's prejudiced mind from his pagan thought that —"an ounce of practice is worth a ton of theory," and they will, in a short time, sell to the glass manufacturers much of their by-products, waste material, or perhaps raw material, at a larger profit to themselves and at the same time enhance the profit of the glass manufacturer.

I regret that I am not in a position to elucidate more clearly this subject; I can, however, point out a few instances to show the possibilities.

In the average glass factory when trouble occurs and the glass contains various imperfections, or when breakage begins to become excessive, the first thing that will be investigated will be the sand pile. The sand will be immediately condemned should it be a little dark in color or a little too fine or a little too coarse, or not exactly of the same shade of color as the sample (which, in many factories, can be found preserved for the purpose of comparison, and which perhaps was selected at a time when some abnormally good runs were made). The next step will probably be to change the sand and get a carload or so from some other source of supply, when in reality sands do not differ by more than 1 or 2 per cent in the amount of silica which they contain.

Now if instead the manufacturer had gone to his lime bin, and had taken a sample of the lime when his trouble started and had it analyzed it is probable that he would have found that the actual calcium oxide content had increased or diminished by 10 or 15 per cent above or below normal. It is possible that he had been using before a lime which carried 80 to 82 per cent of CaO, but on the next order the manufacturers may have been short of his particular kind and may have shipped him a car from some other source or from another one of their mines where the material had been taken from a greater or lesser depth in a stratum of rock, and which may have contained, say, 50 to 60 per cent of CaO and from 20 to 30 per cent of magnesium oxide. Now his melting conditions had been adjusted originally for lime which contained approximately 80 per cent of CaO with only 2 per cent, or at the most 3 per cent of MgO, so that they were not adjusted to the use of the new lime, with the result that the product was "cordy," "stringy" or hard glass.

In another instance the glass worked may have been using an oxide of manganese for decolorizing purposes which contained, say, approximately 80 per cent of $MnO_2$, but for some reason he may have purchased manganese from another source and the material may vary 5 to 15 per cent in $MnO_2$. The result is that the color of his glass goes from white to pink or green, and his glassmaker begins to use various "dopes" for the correction of such troubles, without any knowledge whatsoever of the effect produced by what he uses other than that it is "blue" or smalts arsenic, antimony, borax, cryolite, fluorspar or nitre. Now if the manufacturers of these products would join with the glass manufacturer in investigating these troubles or would furnish material of known composition, the glassmaker would soon learn to appreciate the value of such knowledge.

There are innumerable instances of this kind. If some of our manufacturers would take steps to furnish to the glass manufacturer raw materials of exact composition which would give him a more uniform product with less melting cost and less loss, of if they would, as outlined above, lend some encouragement to the founding of establishments for investigating problems of glassmaking a great deal could be accomplished.

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## A New System of Gas-Firing

By A. C. Ionides*

THE author's method of heating with gaseous fuel dates from June, 1909, when he was carrying out an experiment preliminary to constructing a calorimeter for testing the calorific value of petrol air-gas. The experiment, which was successful, was to ascertain whether or not the flues could be downwardly displaced in a calorimeter, in order to avoid any possible loss of heat.

The first problem that presented itself in applying this new principle was the difficulty of establishing and maintaining a constant mixture.

There are three main variables to be dealt with as regards mixture:

1. The inlet pressure of the air.
2. The inlet pressure of the gas.
3. The variation in consumption of either air or gas that may occur in any given installation.

This first problem was the most difficult of all to solve, since for domestic purposes, etc., it was necessary to deal with differences of pressure sometimes involving a consumption of, say, 2.7 cubic feet of gas per hour.

Nevertheless, after a lapse of four years, this problem was solved by the construction of a device now known as a pressure balance.

It has been suggested that a better name would be a "mixing balance," and the author concurs in this view.

This balance consists of a sensitive bell, with a requisite length of seal. The inside of this bell is subjected to the static pressure of the gas, and the outside to the static pressure of the air. It will be seen that when the static pressure of the gas increases, the arrangement is such that the flow of gas cuts itself off, and the flow of air is, to some extent, increased; and likewise, when the static pressure of the air above increases it shuts itself off, and opens the gas correspondingly, and *vice versa* when the gas and air are decreased. And, it is to be observed, a similar cycle of operations takes place when the consumption of the one or the other is increased or decreased. Therefore by such a device the pressures of gas and air are always held in a constant ratio, whatever be the variation of either the inlet pressure of gas or air, or the consumption.

If a mixture of gas and air be rich in gas, the flame is correspondingly lengthened. On the other hand, if the proportions approach 6 or 7 volumes of air to 1 of gas (according to the quality of the gas), it is quite possible, given silica or any other good catalyser, to have no flame at all, but merely surface combustion.

Now these conditions present great difficulties in heating with a neutral mixture—one which may be said to be neither oxidizing nor reducing—because of the tendency to local heating; and before this was finally and satisfactorily solved another three years had passed.

Should a good catalyser be placed at right angles to a stream of well-proportioned mixture, a glowing disk will be observed. On the other hand, if all catalysers in front of this stream are avoided, the combustion can be spread out to a very considerable length. The author has proved by experience that with a ¾-inch injector, or even with one of ½-inch, it can be spread out to a length of 3 feet of almost homogeneous combustion, by putting the injector into a channel of firebrick opened at the top. In this way the heat units can be distributed in a furnace or boiler, or any other heating apparatus, in a very satisfactory manner.

The third point in the system under description resulted from an observation that the hotter the furnace grew the less was the consumption of gas. By taking into consideration the expansion of gases by combustion, some light is thrown on this phenomenon. What happens if the mixture enters the furnace at, say, normal temperature, 15 deg. Cent.? Obviously, if it act as a perfect gas, it will have expanded $\frac{1700}{273\times15}$ or 5¾ times its initial volume.

If the waste gases, instead of passing into a chimney open at the top, are displaced downwardly through a contracted exit of predetermined cross sectional area, this will cause a resistance to the flow of incoming gases and provide the elements of the most refined thermostat, without any working parts. In fact, by these means the temperature to be maintained can be predetermined with a pencil and a piece of paper.

The fourth problem was how to determine the mixture. After many trials it would seem that the simplest plan is to fit an ordinary gas cock with a piece of copper tubing bent with an easy bend and enlarged at the farther end, and screwed into the injector in such a manner that the enlarged opening at the end of the copper tubing faces the central axis of the delivery pipe, in this way avoiding stream lines.

Now, if a piece of india-rubber tubing and an incandescent mantle be fed with this mixture, the light will indicate the character of the mixture. If the meshes of the mantle are visible, it means an oxidizing mixture. If, however, the mantle is at its most brilliant point, the mixture will be very near the neutral point. But if any unburnt gas is seen to escape from the mantle in the shape of a blue flame, the mixture will be an excessively reducing one. There is a further variable to which reference has not yet been made, and that is the quality of the gas. This can be provided for by external distribution.

Let it be assumed that there is a mixing balance on the air and gas mains entering into a factory, and that all the injectors in the factory are properly calibrated and set for their various functions—brass melting, steel heating, illuminating, etc. When an unwelcome change in the quality of the gas occurs it is immediately visible on one of the lights.

A regulating cock on the air main (preferably a screw-down tap) will at once put this right, and the whole of the factory will be compensated for this change in the quality of the gas.

### ADVANTAGES OF EMPLOYING THESE PRINCIPLES

From what has already been said it will be readily seen that the conditions of conducting heat operations of many kinds on these principles are cleanly, and extremely economical in fuel. The economy also extends to forgings.

There is specially notable the facility with which a reducing or an oxidizing flame can be established and maintained, thus ensuring a consequent absence of scaling. Manufacturers have informed the author that they often have to scrap as much as 90 per cent of their steel forgings owing to scaling.

The figures given by perhaps the largest users of furnaces for steel forging in Europe, after testing, for five months, a furnace for forging machine-gun barrels, were: Saving 50 per cent to 55 per cent; scaling, negligible.

Therefore, it is perhaps unnecessary to state that, even if there were *no* economy in fuel, there would still be a great saving with regard to steel forgings.

A half-ton billet heating furnace has been made, and the figures given with respect thereto were: Gas consumption, 1.3 cubic feet per lb. for full forging heat; scaling negligible.

Messrs. Vickers applied this system to a barrel-heating furnace 36in.×12 in. ×3 in. inside, which resulted in their coming to an agreement to establish this system throughout their works.

As an indication of the correctness of the principles employed, the author would point out that a light worked by means of a pressure balance feeding a small incandescent mantle will produce 130 to 150 candle-power, with a consumption of under 3 cubic feet per hour of town gas of standard calorific value; whereas it can be stated, on the authority of Mr. J. G. Clark,[1] that the highest candle-power light obtainable at this pressure by other systems averages 22 candles-power per cubic foot of gas consumed (variable of course, owing to the atmospheric burner).

To show the saving to the country that would be brought about by use of these devices, it may be recorded that:

1. A 3-inch pressure balance saves 50,000 cubic feet of gas, or 5 tons of coal per ten-hour day, compared with a Brown and Sharp furnace, which is considered by all small arms factories to be the best on the market.

2. One thousand of these devices, in the manufacture of which 240 tons of combined iron castings and steel sheeting would be required, would save in six months—*i. e.*, 180 ten-hour days—the gas distilled from 900,000 tons of coal.

3. Should the barbarous use of raw coal as fuel, which in itself is most wasteful, be discontinued, and this system be found to be equally economical with all forms of producer gas as with town gas, then in this country alone, where 250 million tons of coal are raised every year, these devices would save half this coal; or, in other words, they would double the industrial possibilities of England.

*Abstract of paper read before the British Institute of Metals.

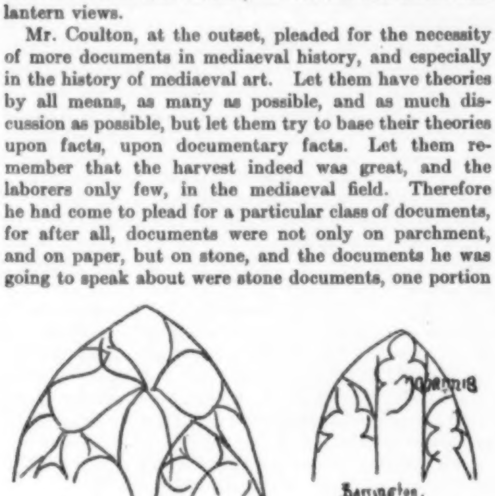
[1] *Gas Journal*, May 4th, 1915.

# Mediaeval Masons' Marks and Graffiti*

## How the Ancient Artisan Vouched for His Work

At a meeting of the Royal Archaeological Institute of Great Britain and Ireland, Mr. G. G. Coulton, M.A., gave an address entitled "Some Notes on Mediaeval Masons' Marks and Graffiti," which was illustrated with lantern views.

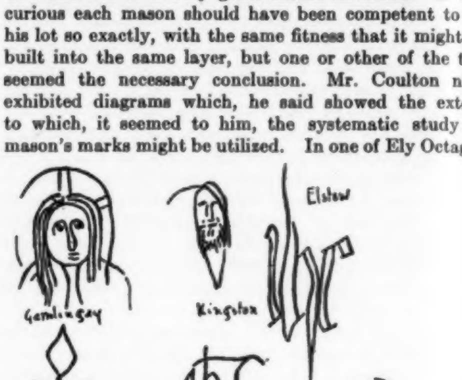
Mr. Coulton, at the outset, pleaded for the necessity of more documents in mediaeval history, and especially in the history of mediaeval art. Let them have theories by all means, as many as possible, and as much discussion as possible, but let them try to base their theories upon facts, upon documentary facts. Let them remember that the harvest indeed was great, and the laborers only few, in the mediaeval field. Therefore he had come to plead for a particular class of documents, for after all, documents were not only on parchment, and on paper, but on stone, and the documents he was going to speak about were stone documents, one portion




of which seemed to him to have been very unduly neglected in a scientific sense, and the other almost totally neglected. So far as his experience went, what was to be read in print on the subject of masons' marks and graffiti was almost wholly to be found in catalogues of them, with a certain amount of application sometimes, and a certain amount of theory. What he pleaded for was something more complete, especially now that County Associations were doing so much to make photographic and similar registers, each of its own district. They wanted something systematic, some synthesis of the millions, they might say, of masons' marks which could be found on a large number of churches, and which a considerable number of people did not notice at all. Speaking first of masons' marks at Ludlow Church, Mr. Coulton mentioned that a heated controversy between two architects in reference to a curious arch was at once solved by a mason who was working on the tower following the masons' marks. A similar problem was presented at Great Barfield Church, Essex. Most of them probably knew the fine screen there, and he thought most people would put that screen at something like fifty years earlier than the rest of the church. Yet they had the distinctive mark of the same mason on both. Why were masons' marks so extremely common in big churches of Norman times, and, again, in big churches of the fifteenth century while so relatively rare, even in large churches, in between? For instance, they were extremely rare by comparison in the thirteenth-century work, on the pillars especially. A typical Norman building in a great Norman church—one of the piers at Ely Cathedral—contained seventy-one marks. That pier represented the work of twenty-one to twenty-eight masons, because, he supposed, everybody was agreed now that, with very few exceptions, the masons' mark was his voucher, his sign-manual.

A mason had to vouch at the end of the week for so many feet of stone, and he vouched them all by his mark. There was much less exactitude in Norman times than in later times. In later times the marks were accurately and neatly cut, but in Norman times very differently. As they knew, the work was done by half-skilled labor, and more quickly than it ought to have been done. He showed a series of Norman marks at Gloucester Cathedral, more carefully cut, more elaborate, less rudimentary in themselves, and there, it seemed to him, came the first important problem in the scientific study of masons' marks. Why was it that finding so many they did not find all? Why were there blank stones? Of course, the obvious common-sense answer was that a mason might mark his work on the back or joint, instead of on the face. But they might look through all the broken stone in any ruin, and they would not find a single voucher mark except on the face. It did not disfigure the face from the point of view of the mason, as the first thing they did was to whitewash and plaster the church when they had finished it. In the north triforium at Gloucester Cathedral the marks were cut so deeply that rarely one was missed, but this regularity of marking was not always found. As an instance to the contrary he mentioned the Infirmary Chapel at Lewes, which was excavated by Sir William Pope about fifteen or twenty years ago. Certain of the stones were magnificently trimmed and carved, and were so hard and fine that where they had been broken up, and built into walls in other parts of Lewes, the masons' marks upon them could still be traced, after all these centuries. Under the plaster the surface was almost as smooth as the plaster, but they would find that a number of the stones had evidently never had a scratch upon them. They knew from mediaeval accounts that the workmen were a fluctuating band. If they followed any mediaeval building accounts they would see that a certain number of people were paid wages week by week for a great number of years, and that certain others came on more or less casually for a short time, and went off again. His theory was that the permanent men did not need a voucher. If a man had been in their employment ten years, and they knew he would do his work regularly, they would not give him the trouble to vouch for his work, though he might do it as a matter of habit. But as regarded the comparatively wandering man they would look carefully to the amount of stone he did each week, and he had to vouch it. The strongest piece of evidence he had heard against that was that in Strasburg Cathedral the same mark appeared on two stones widely separated, and between which there was an interval of something like eighty years. He (Mr. Coulton) had not had time to verify that objection, but it seemed to him there were two flaws in it. The first was that two masons constantly had the same mark, and they had to look at the marks very carefully to see if in size, shape, and so on, they corresponded exactly, before they were sure the marks were made by the same mason. The second objection was that they knew as a matter of fact that stone once cut often lay about for years, perhaps generations, before it was built in. King's College, Cambridge, was a very obvious instance. Proceeding to give two exceptional kinds of masons' marks, Mr. Coulton said the first was in the old St. Mary's Church at Eastbourne, where a large number of the stones—something like two-thirds—had fish marks on them. There had been much discussion about these marks, and an attempt to import all kinds of mystic causes into them. In his view the simplest explanation was that the marks were those of one particular mason who did nearly all the work, and who enjoyed vouching his work in that way, whether or not he was officially compelled to do so. If that man did all the stone marked with fishes, probably only two

masons were at work, and they would think that the mason who did most of the work would not have needed to vouch it. As a matter of fact the fish occurred as a mason's mark at Poitiers in France, and at Bristol and at Canterbury. The other curious kind of mark—he found no instance at all comparable to it—was the "Dammarkn" at the P. de Calais. It was late twelfth or early thirteenth century work, beautiful red sandstone, and all the marks apparently had a numerical signification and ran to a very great extent in strata. It was curious each mason should have been competent to do his lot so exactly, with the same fitness that it might be built into the same layer, but one or other of the two seemed the necessary conclusion. Mr. Coulton next exhibited diagrams which, he said showed the extent to which, it seemed to him, the systematic study of mason's marks might be utilized. In one of Ely Octagon




(north-westwards) they saw, roughly, that stones were built in as the men worked, and as the work progressed a good many of the men went out. At the top was a particular mark, and then there were pillars with the numbers 1, 2, 3, showing that one mason, did one stone, another two, and another three. The table showed a gradual dropping out of certain men, and their replacement by others. These points were more clearly marked in the case of St. Nicholas, Lynn, which could not have been begun long before 1410, and which, as they knew, was finished before 1418. Therefore it was built fairly rapidly, and, as it were, at a single stroke. Taking the walls and pillars they would find that one mason had thirty-five stones, and when they came to the pillars they found this same mason still kept up his high average, having twenty-five stones. Another mason also had a large number, but the great majority of those who were working on the tower part dropped out in the other part. A certain mark at St. Nicholas, Lynn, he had recognized at East Winch, and possibly after St. Nicholas was built this mason passed on to East Winch. At St. Nicholas the bulk of one mason's work was done in the earlier part; another did comparatively little in the earlier part but went on longer. Among the marks were "K" and "W" turned upside down.

A third diagram showed a tabulation of work at Melrose Abbey, which lent itself to more elaborate classification, but was less exhaustive, he was afraid, than the others, because there the weather had obliterated a great deal. As the work progressed towards the east they were able to trace how the men worked. Nearly all the men who were working most in the earlier stage dropped out gradually, and then presently an entirely fresh lot of men, who had not been traced at all previously, came in and worked in the later stage. In the Lady chapel at Gloucester Cathedral, on the reredos, they would find on each panel a very rough sketch of a human figure and the name of some saint. That was to mark into which panels the saints were to be put. The peculiarity of these Gloucester inscriptions was that they were not scratched as the graffiti with the point of a knife, but evidently with a flat tool, about as broad as a narrow chisel. These masons were not accustomed to writing, and they formed the letters very rudely. The masons sometimes used the smooth surface of the stone for sketching, and he instanced an oak leaf and crown and other sketches at St. Albans, where there were a considerable number. There was no doubt when they had a real artist at work. He also mentioned other interesting examples of masons' graffiti at Sion Valias, Offley Church, Herts, Little Dunmow, and other places.

In the course of subsequent discussion the Chairman (Sir Henry Howorth) said Mr. Coulton had virtually tapped an entirely new barrel of archaeological wine. It seemed to him the explanation of the marks that had been given by Mr. Coulton was most rational, and most likely to be the true one.

*From *The Architect* (London).

# Designing and Constructing a Clock*

## A Simple Mechanism That Functions as Well as An Expensive Regulator

By Guy H. Gardner

The accompanying illustrations show how a machinist, with scant knowledge of horology, designed and constructed a timepiece whose running compares favorably with that of "regulators" costing $100 or more. The construction is ordinary lathe work, but the designing called for some knowledge of escapements and compensating pendulums, which were supplied by a friendly watchmaker. As the machinist had no gear-cutting facilities, he was obliged to use stock gears, the pitch of which is coarser than that used in most high-grade clock trains, and the performance of the clock has led him to suspect that undue importance is sometimes attached to fineness of pitch. The high cost of brass led to the use of sheet steel for the plates, bushings of phosphor-bronze being inserted for the pivots to run in. The bushing holes were reamed with what the watchmaker calls a "broach"—a five-sided reamer—and finished with a similar round tool used with oil.

In Fig. 1, *S* denotes sprocket wheels. The large wheel *A* has 240 teeth; the center wheel *B*, 120 teeth; the center pinion *C*, 20 teeth; the third wheel *D*, 72 teeth; the third pinion *E*, 12 teeth; and the escape pinion *F*, 12 teeth. All these are 48-pitch brass gears.—The sprocket marked $S_4$ has its arbor squared on the front end for a key. The arbor carries a ratchet wheel, and a pawl prevents backward rotation; it winds right-handed. The motion work, or "back-gears," shown in Fig. 2, consists of the cannon *A* for the hour hand; the hour wheel *B*, which has 60 teeth of 32 pitch; the minute pinion *C*, which has 20 teeth of 32 pitch; the minute wheel *D*, which has 96 teeth of 48 pitch; the cannon pinion *E*, which has 24 teeth of 48 pitch; and the center staff *F*.

For both ends of the center staff and the escape-wheel staff, which carry the minute and the second hand, respectively, the bushings have a simple straight hole, with a countersink to hold oil, and are without caps. For all other pivots, the bushings are made as in Fig. 3 and are capped with thin disks of hardened steel; this form of bushing causes the oil to be held by capillary attraction about the end of the pivot. These pivots are coned on the end, and are allowed about 0.020 or 0.025 inch end shake. This arrangement makes it possible for the clock to run at least two years before requiring cleaning and fresh oil. The disk *S* is tool steel, hardened and surfaced bright. It is held by fillister-head screws, not shown, the heads of which overlap the disk.

The escapement presents no difficulties after its underlying principles are comprehended. As Fig. 4 shows, the center distance between the escape staff and the pallet arbor is readily determined, either by calculation or by lay-out, as it depends solely on the outside diameter of the escape wheel and the number of its teeth embraced by the pallets. As is usual in clocks beating seconds, this wheel has 30 teeth, of which the pallet embraces 10. As lines *AB* and *AC* are tangent to the circumference of the wheel, it is easy to determine the center distance *AO* and the radii for laying out the locking "planes." The "lift lines"—the beveled edges of the pallet—are at an angle of 30 degrees to the tangents *AB* and *AC*. The so-called locking planes of the pallet are not planes, but, as in all "Graham" escapements, are curved surfaces that have the same axis as the pallet arbor. The pallet is of tool steel, hardened, and the locking surfaces are lapped in the lathe, the pallet being mounted for this purpose on a stud carried by the tool-block.

In all high-grade clocks there has to be some device to keep the movement running during the winding, as otherwise several seconds will be lost each week. For this purpose a spring-driven "maintaining power" is usually employed, but in the present design this is unnecessary, as the drive is by an endless sprocket chain, and the act of winding the clock does not interfere with its operation. The clock was designed to be wound by a key and to run eight days. However, the builder has attached an electric device whereby a small motor winds the clock at the end of every hour for another hour's running, but this is not an essential part of the design. It was added, the owner says, "just to make the clock complete." If the motor or the battery should fail to perform its function, the clock will continue to run until the end of the week.

The pendulum rod is well-seasoned, straight-grained, white pine, and is thoroughly shellacked. It is of elliptic cross-section, except for about 14 inches at the bottom, where it fits a square brass tube running through the center of the bob. The adjusting screw below the bob is cut 36 threads per inch, and the nut has 30 graduations to facilitate regulation; one graduation corresponds nearly to one second in 24 hours.

The bob is of 1¾-inch brass tubing, about 12¾ inches long, and is filled nearly to the top with shot; the exact quantity must be determined by experiment, as will be explained later. The weight and also the dummy weight on the opposite loop of the chain are of the same tubing. This dummy is added solely for appearance's sake, and both weights, like the pendulum bob, are plated with nickel. The driving weight contains about two pounds

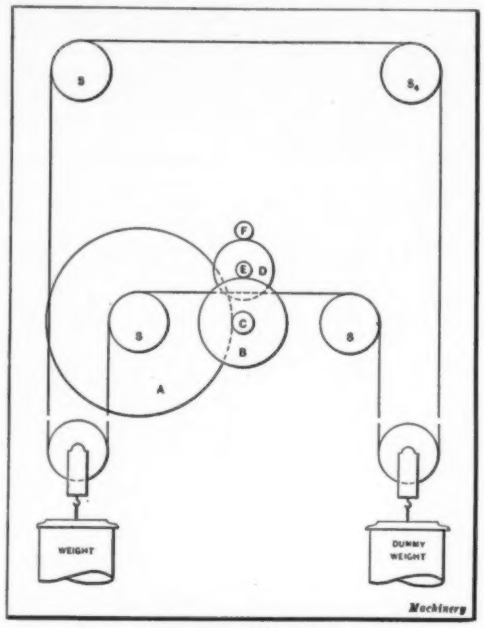
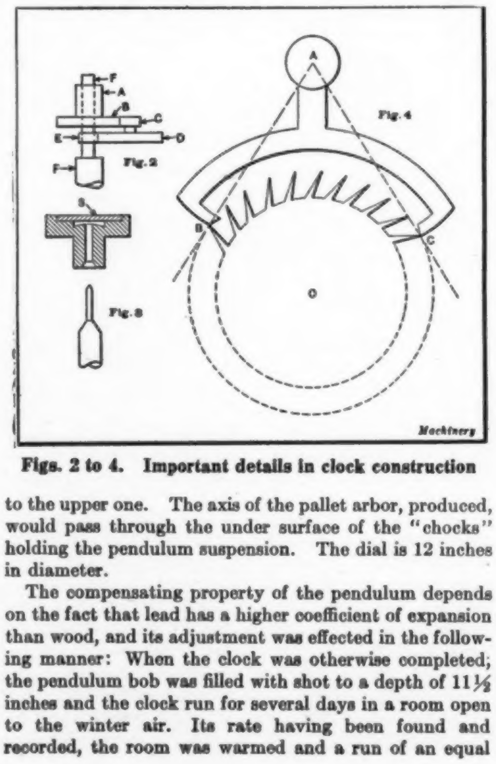



**Fig. 1. Arrangement of weights in clock**

of lead. As all the staffs are of drill rod, the pivots ground after hardening, and the whole train carefully constructed, a much smaller weight will drive the clock, but it was thought best to allow an ample margin.

The case is made of birch, finished to resemble mahogany; it is of unusual strength and solidity. The back is of hard wood, 1½ inch thick, with two strips of ½- by 1½-inch steel set into gains to prevent warping. These strips carry the studs to which the movement is held by a "three-point" fastening, while the piece that carries the suspension spring of the pendulum is bolted




**Figs. 2 to 4. Important details in clock construction**

to the upper one. The axis of the pallet arbor, produced, would pass through the under surface of the "chocks" holding the pendulum suspension. The dial is 12 inches in diameter.

The compensating property of the pendulum depends on the fact that lead has a higher coefficient of expansion than wood, and its adjustment was effected in the following manner: When the clock was otherwise completed, the pendulum bob was filled with shot to a depth of 11½ inches and the clock run for several days in a room open to the winter air. Its rate having been found and recorded, the room was warmed and a run of an equal number of days showed that the compensation was inadequate, as the clock ran more slowly in the warm room. More shot was accordingly added to the bob and the trials in cold and heated rooms repeated. This tedious process was continued until satisfactory compensation was attained, after which the regulation by the nut at the bottom of the bob finished the job.

*Courtesy of *Machinery*.

### Screw Gages

In the course of some notes on screw gages, presented before the Institution of Automobile Engineers, Colonel R. E. B. Crompton pointed out that, though the difficulty of obtaining gages which was experienced at the beginning of the war has been remedied to a certain extent by much hard work at Woolwich, the National Physical Laboratory, and elsewhere, there is no doubt that, had a more satisfactory system been in use and the gages been so designed that they could have been cheaply and rapidly produced in quantity, the country would have been saved many thousands of pounds and much delay in the turning out of shells. The paper on tests on screw gages issued by the National Physical Laboratory showed what extraordinarily fine work is necessary in the screw gages to make them capable of passing the screwed parts of shells sufficiently accurately to allow those parts to be assembled.

With threads of angular form, the fit on the slopes—in other words, the tolerance on effective diameter—is the principal matter to be considered. If this dimension is kept within reasonable limits clearances can be given on both crest and root so that, the fit at these points being unimportant, the tolerances may be large and the parts will still assemble and be a sufficiently good fit on the slopes. Small tolerances on effective diameter lead to increased cost of manufacture, but too large tolerances, generally accompanied by reduction of core diameter, may in some cases reduce the strength of the bolt and nut as a means of holding parts together, though a slack fit is always undesirable wherever bolt and nut are subject to alternating strain or vibration. Tests recently carried out by the National Physical Laboratory to ascertain the effect of excessive tolerance on the strength of the nut and bolt to resist end pressure yielded the expected result, that large tolerances do not appear to have a material effect on the strength until they reach something in excess of 20 per cent of the thread depth.

If high-crested taps having a core diameter somewhat above the nominal are used for all nuts, the high crests will insure triangular clearances at the crests of the male threads, and the increased core diameter will reamer away the inner salients of the nuts, so that the threaded surfaces of bolts and nuts will come in contact only on the slopes. Their good fit is, therefore, a question of the tolerances on effective diameter; the full diameter and core diameter of the bolts may take care of themselves, and if specified at all very wide tolerances may be allowed upon them. If a good fit is secured by tolerances graduated according to the re-requirements of the work on effective diameter, the gaging question can be greatly simplified by practically confining it to the gaging of the male screws by means of an adjustable split nut, accurately made as to pitch and thread form and chased in such a manner that it bears only on the slopes of the threads that are to be tested, and therefore tests the effective diameter only.

The real gage for nuts is the tap, and nothing will improve screw interchangeability so much as improvement in tap manufacture. Errors in pitch introduced in the process of hardening taps must be minimized, and a system of cutting the taps directly and accurately out of hardened blanks should be encouraged. Taps never have a long life; in nine cases out of ten they are thrown aside from breakage before they are appreciably worn, so that if they are correct when new, all the female screwed work formed by them will also be reasonably correct and will hardly require gaging. But if an inspector has to use a gage for the nuts it should be a male plug gage of accurate effective diameter, but with lowered crest and correct core diameter. With the taps proposed, the work should never bear on this form of inspector's gage at these points, and the wear on his gage would be confined to the slopes. Inspectors would always be able to compare this tap testing gage with their reference standard gage by testing it in their adjustable female gages, the latter having been previously checked and adjusted to the reference standard male gage.—Engineering Supplement of the *London Times*.

# The Human Factor in Railway Electrification*

## Making An Electric Locomotive Engineer Out of a Steam Locomotive Engineer

By W. F. Coors, Railway and Traction Engineering Department, General Electric Company

One of the important features of railway electrification is that of dealing with the men who are to run the electric locomotives, or "motors" as practical usage has it. This feature is often not considered until actual operation is to be started, which condition is largely necessary because little effective electrical instruction can be undertaken with practical steam engineers until the machines are actually available for demonstration. Moreover, it is rare that any two railway electrifications will use machines which are in any way identical in practical details; and instruction books, wiring diagrams, and photographs which may have been made for a previous installation will not apply to the new equipment. It is rather difficult to write an efficient instruction book on a new type of machine working under untried conditions, and such a work while it could be generalized at the start would be much more applicable in its details if deferred until its author had acquired considerable practical experience with the actual operating conditions to be met.

Generally, the line work will first receive the close attention of the railway men and later the substations to a lesser degree. While these are being constructed the locomotive is being built at the factory, so timed that the first few will just about be appearing in the field when power is ready to be put on the line. In the meantime the freight engine crews, through work-train line-construction service, will have become well acquainted with such details as come under their observation. They may also investigate the substations at occasional intervals when the opportunity presents itself; and by talking with the construction and line men they may gain the idea that electricity is some mysterious agent which will take them a lifetime to understand, and whose handling will require a deep technical knowledge of wire splicing, insulation, magnetic actions, and high-sounding terms. Up to this stage, the passenger crews will possibly be slower in acquiring such more or less confusing "knowledge." Their observations are more likely to be limited to the increasing difficulty of getting over the road with so many work trains out on the line and to the attendant increase in the number of train orders to be observed. There is also the possibility that a new block-signal system may have to be installed and that the pole line for the trolley will obscure the vision from many order boards and signal posts, thus adding to their difficulties.

During this stage of the work, there will probably be many round-house and switch-shanty discussions pro and con about the prospective change, and various theories put forth as to what it means to the men themselves. Such discussions are quite likely to be founded largely on hearsay gained from some "boomer shack" or brakeman who has worked on many roads; and the men successful in electric operation will later look back on these ideas with amusement and wonder how they ever came to be entertained at all.

Among the rumors which always get out on a new electrification is the one that the manufacturing company will have to furnish electrical engineers to run the motors and that the steam-locomotive men will all likely lose their jobs. This substitution would be manifestly impossible for many reasons, especially on an undertaking of considerable size requiring some 200 men and it would have no precedent anywhere in the past. An electrical engineer would have some little study to become familiar with a new electric locomotive and would require an extraordinary amount of experience in train rules and operation and air brake handling. These latter features, which are more important than any others, have for years been a part of the steam engineer's experience; consequently he will be more efficient with a few days' training on an electric locomotive than any purely electrical man would in be months.

Another subject for discussion among the railroad men is the fact that the new motive power will haul so much greater tonnage per unit that the men well down on the engineers' seniority list will have to go back to firing, the decrease in the number of locomotive running requiring fewer engineers. This objection, while having some grounds, does not work out in practice to the full extent that the arithmetical figures on possible tonnage per train would indicate. Even on a large electrification, there will always be "caboose-hops" where a locomotive will have to run light from one terminal to another as occasioned by the direction of the main freight traffic, work trains, and light local traffic, usually steam. Moreover, on roads where the basis of pay is made on the tonnage rating of the motive power used, the men "firing" the heavy motors will possibly average more per month wages than when running the lighter steam engines; and the more staisfactory working conditions on the electric make up for the slight difference in wages for the heavy work involved in handling steam locomotives of the Mallet type.

The old steam railway men who run a motor will not consent gracefully to being called "motormen"—this sounds too much like street-car work; and the old steam firemen will not generally be termed "helpers" or "assistant engineers" even though perhaps they would not object to these terms. As an old "electrified" passenger engineer says, "The fire-boy fires the train-heating boilers and is not much help or assistance anyway. You electrical men are going too far with these 'helper' and 'assistant' names when applied to ordinary tallow-pot smoke-makers."

However, as soon as the electric locomotives are in operation all objection by the *engine* crews to heavy trains ceases, there being no difference in their work whether they have 40 or 100 cars in a train; but this objection is taken up by the *train* crews with increased vigor. The "car-captain's" or freight conductor's car records, termed "hard" or "soft" lists, get as large as a dictionary, and the work of setting out cars at stations and the mile walks from the rear to the head-end of the train total quite a little at the end of a day's work. To lessen such difficulties, various expedients are often lightly suggested, such as sky-rockets and smoke bombs to signal from the caboose or "crummie" to the engineer; a telephone system along the train with a portable attachment which can be plugged on on any car; a smooth run-way on top of the cars so that roller skates can be used by the train-men; and a smooth foot-path along the sides of the track so that at any stop the men could ride bicycles when making car inspections and in carrying train-orders up to the engineer.

Under steam operation methods where the locomotives may be changed every division of 110 miles, it is also customary to change the caboose as well. For this reason every freight conductor will have his own "private car," homely it is true but his very own, and will have it fitted up with the necessary culinary utensils and sleeping equipment according to his bachelor ideas. In fact, some of them get so that even when at home terminals they would rather be aboard the old "crummie" than at home tending to the garden or helping out in domestic roles.

But when the motors take hold of a train, they stay with it for at least two divisions and the respective crews make a "main-line change" at the intermediate division point. The train is not broken up and the caboose goes straight through; all the paraphernalia of the one crew being thrown off and that of its successor being put aboard. The running time over the old divisions may be shortened from 12 to eight hours, and so, everything considered, even the train crews may look favorably on the motors. Among the best boosters for the electric operation may be found railroad men's wives, who somehow find their husbands' home time about doubled.

Many of the train operating men are skeptical about their chances of escape in case of a wreck when the trolley wire may get down on the ground or cars and electrocute the whole personnel thereon, leaving the train to run wild. This condition looks easily impossible to the electrical engineer, but it is not easy to explain away from the minds of men who have never had any experience with electricity. From this standpoint alone, the old operatives are preferable to men who have had a little experience with low-voltage circuits, just enough to be fool-hardy with higher voltage. The steam men know nothing about "juice," they admit it and are ready to go to extreme precautions before undertaking the handling of any electric apparatus whether energized or not.

It is significant that in a recent large electrification only a few serious accidents have occurred and that none of these have happened to the men operating the trains; the very men, in fact, who had never handled electric energy before and who perhaps have the major part of this work to do in actual operation. Pantographs have been wrecked and tangled in the overhead work, steam locomotives have caught and torn down the wire, snow slides have taken out long stretches of pole-line, and, in rare instances, the wire has broken and dragged on the roofs of the steel passenger cars, yet with all these troubles nothing more than a slight scare of the witnesses has occurred.

In one instance at the beginning of electric operation, when the passenger trains were still equipped with steam locomotives, a broken wire on a severe curve hung down and struck the train, throwing out fire at every contact. The engineer, following a life-time practice for all kinds of accidents, immediately stopped the train. The dining car came to rest under the broken place and amid the sputtering and flashing it is said that one of the colored waiters knelt down between the tables and prayed, "Oh, Lawd, make this coon a better niggah." However, no great damage was done and the engineer learned a new feature in electric operation for future practice, *i. e.*, if a stop cannot be made before reaching wire trouble, to keep on running through until entirely clear of it.

In fact, it was a little difficult for the engineers to realize just how important the trolley wire and pantographs were, until they had an accident or two involving these equipments. In the early stage of their learning, they were intent on the operation of the locomotive only, and if they were headed by a careless switchman into a track which had no trolley wire, it was ten chances to one that they would take the signal and back right into it only to discover that they had a dead motor and couldn't get back to the wire again or the pantograph had been caught and smashed against the overhead span wires. However, with a little experience of this kind, it soon became second nature for the men to watch the trolley wire almost as much as the track. This, on electrified roads, will evidently require a slight change in the rendition of that old "Casey Jones" song wherein the "hogeye" engineer is supposed "to keep his hand on the throttle and his eye on the track," to include the trolley work as well.

At present on this electrification, wire, and pantograph trouble is almost eliminated excepting that which comes from shifting or settling track or change in the outer rail elevation on curves. The men have been instructed never to go on top of the locomotives or to open any covers over electrical apparatus in the locomotive with either of the pantograph current collector up against the wire. Each locomotive is equipped with a long pole hook and dry rope which can be used to pull a pantograph out of a wire entanglement, and in rarely bad cases the power is cut off at the substations by request from a portable set attached to the despatcher's telephone circuit and the line grounded at the motor. Since there are two pantographs on each machine, it is comparatively easy to disconnect one which is damaged and to use the other one in operation. The trouble from this cause rarely occasions a delay of more than 30 minutes.

Another viewpoint, from the human comfort side, was that before the electric locomotives were put in operation and for some time afterward the men operating them thought they were extremely cold affairs in winter time. This was perfectly natural for men who had been accustomed to work with their knees up against a hot boiler head and with leaking steam all around. This complaint was easily overcome by placing a small electric heater in front of the engineer's operating position, and with the much drier working conditions many old chronic cases of rheumatism and winter sickness among the men have disappeared with consequent fewer lay-offs and winter vacation trips to warmer climates.

With this type of motor the engineer is located at the "front of things" and many of the men at first wondered what would be left of them in case of a head-on collision. For quite a while, one of them in pusher service persisted in using the rear-end operating cab for fear that the cars up ahead might smash through the head end of his motor. Several accidents, which with steam engines the men admit their chances would have been slim, have demonstrated that the electric locomotive cab construction and arrangement takes very good care of them in such emergencies. The unobstructed front view not only gives the men a chance for earlier warning and more time to apply air brakes at the prospect of a coming collision and so minimize its effect, but also they can take steps "to unload" themselves and get out of danger. There have been cases where these machines have run into landslides and rolled down embankments not injuring the men at all. The pantograph in such cases immediately leaves the wire and the machine is electrically dead. There are no steam pipes to burst, red-hot fire boxes with gas and smoke to overwhelm the men caught in the cab, nor tender with flying coal to crash

*From the *General Electric Review.*

up into the cab. With a steam engine, as one old timer said, "It's not the first smash I'm afraid of so much as the hell let loose afterward, especially if I get caught in the cab and can't get out."

The operating men on this electrification regard the whole arrangement as a success. The shorter working hours, the cleanliness of the surroundings at work, little on the locomotive requiring close attention, less danger involved, no anxiety as to whether they have enough coal or water to reach the next supply, increase in pay and confidence in the equipment through a thorough knowledge of its operating details, etc., has won many friends to the electric locomotives from the men who use them and who, it is admissible, could make or break the success of any type of motive power.

From this viewpoint, that the ultimate success of electric operation finally depended on the men themselves, the railway officials were especially lenient with them for all electrical detentions and every effort was made to give the best opportunity for becoming familiar with the motors at the start. The men were in turn very receptive of all instructions given them and were able to remember and willing observe such instructions with very little repetition.

The first division was put under electric operation as soon as several motors arrived from the factory. Men were sent out by the manufacturer as instructors to ride with each and every new engineer when his turn came to go out on a motor until he should be sufficiently qualified to operate alone. These factory men were variously termed "experts," "instructors," "inspectors," and in some cases "slickers" by the facetious. They were called out by the regular call-boy who summoned the train crews to duty, and many an hour's "terminal-delay," which gives double-pay to the crew called if the train does not pull out of the terminal within an hour after it is supposed to, was occasioned by the call-boy who often forgot that a motor crew consisted of three men instead of the usual engineer and fireman. Lists of men who were "qualified" by the instructors were posted in all conspicuous places, and there was some friendly banter coming to the men who were a trifle slower than the average in "getting hep" to the new machines. It cannot be said that the younger men were exclusively able to qualify quicker than the older ones but such was generally true. However, from an instructor's point of view, when one of the older men did express his confidence in himself and showed sufficient progression, there was no need to worry about him later, while the boys who had lately been "set-up" from firing were likely enough to call for help over the dispatcher's telephone when out in the middle of their run. It always gave the older men a great deal of satisfaction to be able to help them out of some such minor difficulty if they met on the road.

Since the airbrakes were practically identical to those used in steam practice, this feature tended toward greater confidence in the engineer who almost invariably said to the instructor on the first run, "Well, you may have to start her up but I know how to stop if necessary."

One young engineer after successfully hauling a long train up to the summit of the worst grade on the road, said to the instructor, "Here, *you* take her down the grade. I've only been running as engineer for a short time and have never been down here before even on a steam engine." Here was something of a quandary. The instructor had never been down the grade but a few times himself and then had not handled a train and was in nowise anxious to figure in a runaway. But considering the great confidence given the factory men at the start by the railway, it was imperative that something should be done to warrant it for the future. The train was safely brought down the hill, regenerative braking making it easy. Here, in the engineer's charge, the train was "made-up" to 90 cars with a dead Mallet locomotive on the rear end. This was an ideal train for even an expert to handle and the engineer proved his right to be "set-up" by pulling into the terminal without a mishap. The next week he was qualified for running a motor.

On the succeeding three divisions, instruction work was much easier. The men would talk over the new machines among themselves and their various experiences with each particular feature, so that much instruction work could be briefly passed over. The Railway company placed a caboose at the instructor's disposal at terminals for an instruction car, and the men after being out on the road were very willing to drop in for a few minutes to talk and become acquainted with the motor blue-print wiring diagrams and learn just what operation details were necessarily required. Later, instruction books were prepared and distributed to each engineer for home study, and to their credit it may be said that the books proved to be a valuable aid to the instructors who it seemed at first had tackled an endless job. By these means, the period of actual road instruction per man was cut down from one to two weeks to a maximum of five days and in many cases to only two days. In each case, however, as work on a new division was about to be started, the men who had already qualified in electric operation would honestly offer the assurance that the men on the next section would "take a year's time to learn anything. We all had to go over there and show them how to use the oil-burners"—or mallets, or some other new motivepower innovation that the Railway Company had installed in times past. This friendly rivalry between the divisions always inspired the newer men to extra effort. In fact, on the last division to be put under electric operation, it was not uncommon for the instructor who was called to go out on a run with a new man to find him already coupled up to the train, the air tested and merely waiting for orders to go.

Passenger engine crews were given more work in learning than the freight men since on through-runs there was little opportunity to show up the "fine" points to be learned. These men usually had a half-day off every other day and came to the round-house where an instructor would purposely remove fuses on a spare locomotive, put match stems in the relays, and cause a multitude of troubles for the engineers to locate and remedy. Due credit must be given to the Railway Company's regular traveling engineers who took hold of this line of electrical instruction and becoming proficient themselves, were able to offer valuable assistance in getting their brotherhood into the game at an early date.

Here, as in all lines where teachers deal with some new phases of instruction, they often learned more than those they were supposed to teach. The different methods used by the men in handling long trains and short cuts in switching, hand and lantern "short-hand" signalling, and many other practical details, all of which are slightly different in railway practice than as taught in the rule books, were of educational value.

The technical terms used by the electrical engineer for apparatus and electrical quantities are readily taken up by steam men where they are not confusing or where one term for the same thing is strictly adhered to. It is easy to explain the difference between kilowatts and kilowatt-hours to the beginner, but the various indefinite distinctions *drawn* by technical men between potential, tension, and voltage—for example, when referring to electric pressure—are not readily received by operating men who are told that such pressure is measured in *volts* and who, therefore, are prone ot conclude that the proper term should be "voltage" and that exclusively. While water and air pipe analogies are useful in explaining direct-current actions, they fail on practical hearers when alternating current is dealt with. Steam, water, and air valves when *open* permit the flow of current while electric switches and contactors permit the flow of current when *closed* so the old steam man must be excused sometimes if he wonders what a set of instructions or wiring diagrams mean if these terms are used indiscriminately or if they sometimes allude to contactors as *switches* or relays as *regulators* depending on the purpose for which they are utilized. He can only judge from the external appearances when beginning, and if such a piece of apparatus on the electric locomotive is called one thing in one location and a similar affair is called something entirely different when in another location, it can only mean an extended length of time before the steam locomotive engineer can become qualified for electric locomotive operation.

## Vulcanization Catalysts

By S. J. Peachy

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In a paper brought before the Annual Meeting of the Society of Chemical Industry by Dr. D. F. Twiss on the chemistry of vulcanization (this Journal, 1917, 782), a comparison is made between the accelerating effect of *p*-nitrosodimethylaniline and that of certain alkalis, ammonium salts, and ammonia derivatives. Dr. Twiss prefaces the account of his experiments with the statement that "almost the whole of the known effective organic accelerators are basic, a rough proportionality apparently existing between their activity and their alkalinity, relatively feeble bases like aniline and methylaniline having little influence on the rate of vulcanization," and his line of investigation appears to have been directed wholly from this standpoint. The erroneous impression that basicity is an invariable concomitant of accelerating power is thereby likely to gain ground, and as this may mislead other workers in the field, I think it is desirable to place on record one or two new facts which are opposed to the above view.

There can be little doubt that in the case of most of the known vulcanization catalysts the accelerating power is in some manner bound up with the possession of basic or alkaline properties; further the results of numerous experiments which I have personally carried out point to the fact that the dissociation constant $1 \times 10^{-8}$ referred to in Bayer's patent does actually form a dividing line between accelerating and non-accelerating bases and that all the useful accelerators of the basic type appear to be covered by their claim. Organic (and inorganic) bases, however, constitute merely a particular class of accelerator; there undoubtedly exists at least one other class represented at the present moment by certain organic compounds which contain the nitroso group directly linked to a benzene ring or similarly constituted nucleus. Of these *p*-nitrosodimethylaniline was the first to be discovered and is probably the most effective. The activity of accelerators of this type appears to be in no way connected with the possession of basic properties and such activity may be exhibited even by substances of distinctly acidic character. Even where accelerators belonging to this group are basic their basicity is naturally low and would probably in every case fall far below that represented by the dissociation constant $1 \times 10^{-8}$.

The following facts will suffice for the present to show that nitroso compounds owe their accelerating properties to the presence of the nitroso group directly connected with a carbon nucleus and not to any basic properties which they may happen to possess.

1. Dimethylaniline (dissociation constant $2.4 \times 10^{-10}$) is destitute of any appreciable accelerating properties although it is a stronger base than *p*-nitrosodimethylaniline (dissociation constant $1.9 \times 10^{-10}$).
2. *p*-Nitrosodimethylaniline possesses a dissociation constant lying far below $1 \times 10^{-8}$. Up to the present all the known powerful accelerators of the basic type possess a dissociation constant lying above this figure.
3. *p*-Nitrosophenol and its homologues, although acidic in character, exhibit marked accelerating power.
4. *p*-Aminophenol, in which the basic $NH_2$ group replaces the acidic NO group of the nitrosophenol, exhibits no appreciable activity.
5. Whilst nitroso-bases are powerful accelerators the isomeric nitrosoamines (in which the nitroso group is not in direct combination with the nucleus) are inert.—*Journal of Soc. Chem. Ind.*

## Food Tests of Shark Varieties

A shark fishing trip along the Atlantic seaboard was recently undertaken in the interests of food conservation by Russell J. Coles of Danville, Va. a hunter of big game fish. Eighteen varieties of sharks and rays were caught and tested as food and found agreeable in flavor and highly digestible. Mr. Coles made the following report upon his trip:

Nurse shark, fairly good for food, although tougher than most species; smooth dogfish, one of the most delicious fish that exists; Ione shark, excellent for food; cub shark, of strong odor but, when specially prepared, suitable for food; large shark, good food; sharp-nosed shark, when properly prepared, an excellent food; hammerhead shark, a crowning dish for dinner; bonnet-nosed shark ranks well up as food; and sand-bar shark, most desirable for food; smooth or barndoor skate, excellent for food; clear-nose skate or briar ray, good eating, similar to shrimp; small electric ray or shark fish, without odor, flavor delicious; large sting ray, good for food; sand skate or butterfly ray, good for food; spotted sting ray, lady skate, excellent for food, flavor similar to bluefish; cow-nosed ray, flavor similar to scallops; eagle ray, excellent, with the flavor of scallops; small devilfish, delicious.

The flesh of a few varieties of sharks has a strong flavor. Where the meat is without any odor sharks may be cooked without any preparation, just as we would use bluefish or mackerel, and they are fully as good. In preparing the fresh meat of those sharks which have a strong objectionable odor it is well to cut it into slices about three-quarters of an inch thick, salt it heavily for 30 minutes, then soak the salt out of it, parboil for a few minutes, change the water, again parboil for a few minutes, wash and remove the surplus water with a cloth or by hanging it up for a short time, then cook and serve hot. The meat of these varieties can be fried, or, better still, baked with seasoning of onion, tomatoes, mustard, vinegar, sugar and potatoes. Plenty of pepper will answer. The salted meat of the shark should be heated before cooking in the same manner as fresh meat, and them put through a meat chopper and cooked into highly seasoned balls.

There is not a fish in the sea more maligned than the shark. Although there are individual sharks that turn scavengers, and there is one variety of white shark which has been known to attack human beings, the shark leads an exemplary life. Some of the varieties are fastidious in their choice of food, as, for instance, the hammerhead shark, which subsists almost entirely on Spanish mackerel. There is no reason at all why the flesh of many varities of shark should not be canned, and that under their true names.

## NEW BOOKS, ETC.

LIGHTHOUSES AND LIGHTSHIPS OF THE UNITED STATES. By George R. Putnam. New York and Boston: Houghton Mifflin Company, 1917. 8vo.; 321 pp.; illustrated. Price, $2 net.

The giant warders of our coasts, beautiful in sunshine and majestic in storm, must always appeal strongly to the heroic element in mankind. They are made possible, however, only by the existence of a great, far-seeing plan and organization of which titanic engineering and "big business" are component parts. Mr. Putnam gives us much of granite rock, crashing waters, and deeds of daring, but the chief value of his work lies in its simple record of lighthouse history and development, of government organization and achievement. There are general descriptions of our famous lights, with good pictures of many of them, and explanations of the apparatus in use, there are chapters on lightships and tenders, buoys, fog signals, and the lightkeepers, and a brief review of the lighthouses of other countries and of antiquity. Altogether, the United States Commissioner of Lighthouses has given us a most attractive, informing, and authoritative volume.

STEAM BOILERS. Revised by Robert H. Kuss, M.E. Chicago: American Technical Society, 1917. 8vo.; 93 pp.; illustrated. Price $1.

"Steam Boilers" is a simple yet practical discussion of materials, manufacturing processes, and requirements. With steam pressures carried up to 250 pounds per square inch, the consideration of safety takes a paramount place, and the embodiment of this element in design and construction is carefully demonstrated. The modern flue, fire-tube, water-tube and marine types of boiler are separately examined in the second part of the treatise, with illustrations that materially aid in conveying the outstanding features of the various types. The work answers every need as a concise summary of boiler requirements and how these have been satisfied in the great modern power plant.

THE WAR AGAINST WAR. And the Enforcement of Peace. By Prof. Christen Collin, Christiania University. New York, Boston and Chicago: The Macmillan Company, 1917. 12mo.; 175 pp.

In nine collected essays an eminent Norwegian scientist and humanist blames a false interpretation of Darwinism for the Teuton justification of wars of conquest. He terms the present war "one of the greatest scientific errors of all time, the fruit of a lopsided technical devlopment accomplished at the expense of the science of society." His cheery belief in the power of the human will and intelligence to right the wrong, and his admirable handling of the facts in the case, result in a work that all may read with benefit. He regards as quite practical a universal and lasting peace, but only when a sufficient number of nations combine to "put might back of right." Incidentally, an interesting light is thrown on the failure of the Ford Peace Mission.

EXPERIMENTAL BUILDING SCIENCE. By J. Leask Manson, B.Sc. New York: G. P. Putnam's Sons, 1917. 8vo.; 218 pp.; illustrated.

This work, in two volumes, is written especially for the building departments of the technical schools of England, and some knowledge of elementary science and simple calculations is assumed. The aim is, by making the student familiar with practical, experimental and mathematical methods of investigation and with the nature and properties of building materials, to fit him to understand the larger problems connected with the use of materials and the design of buildings. The first volume, just issued, confines itself to principles, materials, and terminology, with problems and experiments that should greatly help the reader to a close acquaintance with apparatus and tests of various kinds.

HOW TO FLY. By A. Frederick Collins. New York: D. Appleton and Company, 1917. 8vo.; 193 pp.; illustrated. Price, $1.10 net.

AIR NAVIGATION FOR FLIGHT OFFICERS. By Lieutenant-Commander A. E. Dixie, R.N. New York: D. Appleton and Company, 1917. 8vo.; 234 pp.; illustrated. Price, $4.00 net.

At the opening of the great conflict, aviation was a rickety youngster that nobody seemed to own; War adopted it, and now it is a lusty, promising youth that is going to serve Peace even better than he is now serving War. Mr. Collins' simply-worded instructions are "for aeroplanists, for those who would be, and for those who are interested only in reading about them." It is a handbook covering briefly the whole field of principles, construction and operation, with particular emphasis on learning to fly; the beginner is made familiar with the location, fees, and requirements of schools, and with the necessary qualifications and steps for joining the United States Flying Corps. The aspirant using this text should readily acquire a theoretical knowledge of aeroplanes, engines and equipment, with a fair idea of how they are used in war. In "Air Navigation for Flight Officers" Lieut.-Commander A. E. Dixie undertakes to summarize the facts of magnetism and the features, uses, and adjustments of the compass; there are chapters on the correction of courses; on meteorology and weather forecasting; on astronomy and time, with an explanation of nautical tables; on chart symbols and chart work; and on many other important phases of aerial navigation. It should prove a valuable compilation for all aeronautical students who really wish to master the subtilities of his subject.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA. 1918. By A. L. Dyke, E.E. St. Louis: A. L. Dyke. 8vo.; 900 pp.; illustrated. Price, $3 net.

The value of this work lies not so much in the fact that it contains reliable information on any point which the novice, the operator, or even the repairman may need to have explained, but rather in the fact that the author is a specialist in instruction; and while this sixth edition is a comprehensive volume scrupulously compiled, it is the way in which the subject-matter is presented that most distinguishes it from the ordinary handbook. Constructions of all kinds, whether of the car itself, the engine, or accessories, are first presented in their simplest form, that the principles involved may readily be grasped before the student is initiated into more complex features. In this connection many of the thousands of illustrations are freely exaggerated whenever knowledge can thus be most quickly and surely imparted. The work treats of assembly from the ground up, engines, carburetion, cooling and lubrication, ignition, electric systems, the storage battery, operation and care, license laws, salesmanship, tires, troubles and remedies, and repairs, covering a very extensive field. There is a section on trucks and tractors, a dictionary, and five colored inserts. The index contains 6,000 items, and the new edition is a material improvement upon the issue of last year.

THE ANIMAL MIND. A Text-Book of Comparative Psychology. By Margaret Floy Washburn, Ph.D., Professor of Psychology in Vassar College. New York: The Macmillan Company, 1917. 12mo.; 386 pp.; illustrated. Price, $1.90.

Since the first appearance of this work, nine years ago, research in comparative psychology has taken such forward strides that a revised edition, including the more important findings of the new knowledge, should be eagerly received. It acquaints the student with the experimental work of several hundred authorities, excellently summarized under the various sensory perceptions, reactions and discriminations. The author evidences an acute sense of the weaknesses that have marred past methods; she places the reader on guard against faulty observations and improperly supported conclusions, teaching him to weigh data accurately and to make due allowance for the unknown factors that oppose our every step as we try to probe the capacities and limitations of that lower world whose reaction to stimuli may easily be so vastly different to our own.

HAND GRENADES. Compiled and illustrated by Major Graham M. Ainslie. New York: John Wiley & Sons, 1917. 12mo.; 64 pp.; illustrated.

The war has demonstrated the importance of many weapons that we had come to regard as obsolete, among them the hand grenade. Major Ainslie's manual sets forth the various types of rifle and hand grenades in use by the Allies and their opponents, showing the "chains of authority" and methods of attack. The student is taught to handle, strip and assemble each type, and is made familiar with fuses and detonators.

CHEMICAL ENGINEERING CATALOG. 1917 Edition. New York: The Chemical Catalog Company. 4to.; 517 pp.; illustrated.

This reference work is now in its second year and contains double the information of the first issue. Of the two sections into which the work is divided, one is devoted to equipment of particular interest to the engineer and operating manager, the other to catalogue data on chemicals and materials for the benefit of the buyer. The items are not confined to chemicals and chemical apparatus, but enter also the realm of pumping, power transmission and conveying machinery, and even touch upon the question of industrial locations. The profession will find in it a wealth of specific and important information, since it is much more than a general list of products, the descriptions often giving detailed sizes, weights constructions and uses. It may, too, suggest ideas for the utilization of materials and devices originally designed for other purposes but readily adaptable to our enlarging needs and demands in industrial chemistry.

LOVE SONNETS OF AN OFFICE BOY. By Samuel Ellsworth Kiser. Chicago: Forbes & Company, 1917. 16mo.; 47 pp.; illustrated. Price, 50 cents.

Do you remember how desperate a thing love was when you were fourteen, and She was twice fourteen? The humor and the pathos of it will all come back to you as you read this classic of boyhood; for it is safe to say that all of us once treasured up "a little hatpin that she wore," and "wisht that some time she'd drop something more."

PLANE AND SOLID GEOMETRY. By John C. Stone, A.M. and James F. Millis, A.M. New York, Boston and Chicago: Benj. H. Sanborn & Co., 1916. 8vo.; 448 pp.; illustrated. Price, $1.35 net.

This revised edition of a work that has been in wide use since 1910, and which was the pioneer in departing from traditional Greek geometry, offers a concrete approach to the basis science of magnitude, arouses the interest of the student by including many real-life problems, and skilfully links the subject-matter to algebra on the one hand and trigonometry on the other. The use of the suggestive method in the treatment of theorems is a feature of the text. In its new form the work appears to be still further simplified, original thinking is carefully fostered, new exercises are introduced, and new cuts have been made for all the figures.

THE ELECTRON. Its Isolation and Measurement and the Determination of Some of its Properties. By Robert Andrews Millikan, Professor of Physics, the University of Chicago. Chicago: The University of Chicago Press, 1917. 8vo.; 280 pp.; illustrated. Price, $1.50 net.

Professor Millikan addresses this work not only to the physicist but also to the interested layman; that the latter may follow the progressive discoveries without interruption, all mathematical proofs and detailed analyses are relegated to appendices. The introduction sets a standard of interest that is carefully maintained throughout the work, and academic and practical considerations are correlated and clarified. The electron theory as it stands at present is an outgrowth of modification from research to research, and it is the history of this research and growth that the author transcribes. From the earlier investigations and a general proof of the atomic nature o. electricity the work proceeds to a consideration of the exact evaluation of $e$, the mechanization of ionization of gases by X-rays and radium rays, Brownian movements in gases, the possible existence of a sub-electron, the structure of the atom, and the nature of radiant energy.

EXPLOSIVES. By Arthur Marshall, A.C.G.I., F.I.C., F.C.S. Vol. II. Philadelphia: P. Blakiston's Son & Co., 1917. 4to.; 412 pp.; 80 illustrations. Price, $8 net.

The second volume of this timely work is devoted to the properties of explosives and the tests to which they are subjected, with studies of pressure and heat, power and violence, and ignition and detonation. Five chapters are used to describe military, commercial and coal-mine explosives of a special nature; the section on stability is introduced by a consideration of magazine and workshop construction, in which American, English, German and Austrian practice is outlined and compared and a valuable table of distances is offered. Under "Materials and Their Analysis" the various substances are discussed in alphabetical order. Appendices give the regulations of the Imperial German Railway Commission and thermo-chemical tables, and deal with the conversion of units; in addition to a full index of subjects, there is a separate index of names, in which each reference to an investigator is connected with his particular fields of activity. The two volumes constitute an authoritative and fairly exhaustive summary of knowledge and practice down to the commencement of the war.

EXPORTERS' ENCYCLOPAEDIA. New York: Exporters' Encyclopaedia Company, 1917. 8vo.; 1323 pp.; illustrated. Price, $7.50.

The 13th edition of this standard guide offers very complete and reliable information relative to export shipping. Routings and consular regulations may quickly be found for any important port or city of the world; foreign and domestic postal rates and conditions, ocean freight rates, cable rates, and general shipping instructions preface the work; many valuable tables and statistics follow. The body of the encyclopaedia is given over to the various countries of the world, from Africa to Windward Islands, with maps, political and geographical divisions, information as to area, population, commerce, products, the points through which bills of lading are issued, commission houses, and shipping routes. The purchase of the work carries with it certain services and privileges that keep the shipper notified of important changes throughout the current year, enabling him to avoid annoying and costly mistakes.

MODERN MACHINE SHOP CONSTRUCTION, EQUIPMENT AND MANAGEMENT. By Oscar E. Perrigo, M.E. New York: The Norman W. Henley Publishing Company, 1917. 8vo.; 348 pp.; 219 engravings. Price, $5.

The modern machine shop is worthy of the most constructive thought and the application of the best inventive and organizing ability. This work recognizes the three elements of success: the architectural features of the shop itself, the equipment, and the management; under these three headings it outlines practice and systems that are in actual, daily operation, and that may therefore be relied upon as combining simplicity, economy and effectiveness. This second and revised edition also carries entirely new chapters on increasing the efficiency of men and machinery, the relation of overhead burden to flat cost, and manufacturing cost systems. The author conveys a great deal of information in condensed form, and his object is furthered by the many specially-drawn illustrations. The excellent features of the work will be appreciated by the manufacturer, and by his architects, engineers, superintendents and accountants; there is also much that is of value to the foreman and shopman.

PATRIOTIC TOASTS. By Fred Emerson Brooks. Chicago: Forbes & Company, 1917. 16 mo.; 94 pp. Price, 50 cents.

All written since America's entrance into the war, these toasts pledge our flag, our fighting men, and our national ideals. Their sentiments will find a response in every patriotic breast, and the pointed bullets of their humor nearly always ring the bell.


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